KANNUR UNIVERSITY
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(Abstract)

FYUG Plant Science Programme - Typographical errors in the Syllabus - Rectified and implemented w.e.f 2024 Admission - Orders Issued

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ACADEMIC C SECTION

ACAD C/ACAD C3/21060/2024 Dated: 01.07.2026

Read:-1. U.O No.ACAD/FYSC -III /21060/2024 dated 17/11/2024

2. U.O.No. ACAD C/ACAD C3/21060/2024 Dated: 27.09.2025

3. U.O.No.ACAD C/ACAD C3/21060/2024 Dated: 19.12.2025

4. E-mail dated 18/06/2026 from the former Chairperson, Board of Studies in Botany (UG)

5. Orders of the Hon'ble Vice Chancellor in the file of even number dated 1.7.2026

ORDER

1.The Scheme (I-VI Semesters) and Syllabus (I & II Semesters) of the FYUG B.Sc. Plant Science Programme - was approved & Implemented w.e.f. 2024 Admission as per paper read (1) above.

2. The Syllabus of the Third Semester FYUG Plant Science Programme , was approved and implemented in affiliated colleges w.e.f 2024 admission, as per the paper read (2) above.

3. The Scheme (VII & VIII semesters) and Syllabus (IV-VIII semesters) of the FYUG Plant Science Programme was approved and Implemented with effect from 2024 Admission, vide paper read (3) above.

4.The former Chairperson, Board of Studies in Botany (UG) vide paper read as (4) above submitted the typographical error rectified syllabus of the FYUG Plant Science Programme (V & VI semesters) for approval .

5.The Vice Chancellor after considering the matter in detail has approved the typographical error correction made in the approved syllabus and permitted to upload the rectified Syllabus on the University Website.

6. Orders are issued accordingly.

7. The rectified syllabus is attached to this U.O and uploaded on the University Website.

Sd/-

Bindu K P G

Joint Registrar (Acad)

For REGISTRAR

To: 1. The Principals of Affiliated colleges

2. The Controller of Examinations (Through P A)

3. Chairperson, Board of Studies in Botany (UG)

Copy To: 1. PA to CE (to circulate the same among the sections concerned under Examination Branch)

2. PS to VC/PA to R

3. PS to VC/PA to R

4. JR II (Exam)

5. DR/AR (Academic)

6. Web manager (to uploading on the website)

7. Computer Programmer

8. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY CIVIL STATION P.O. KANNUR Pin-670 002

KANNUR UNIVERSITY
കണ്ണൂർ സർവകലാശാല
Re-accredited by NAAC with 'B++' Grade

KANNUR UNIVERSITY FYUGP SYLLABUS

B.Sc. PLANT SCIENCE

Effective from 2024 admissions

2024

CONTENTS

Foreword

The Four-Year Undergraduate Programme (FYUGP) in BSc Plant Science is undergoing rigorous transformations to better align with the evolving needs of students, industries, and society at large. Recognizing education as a cornerstone of progress, it's imperative that the curriculum reflects contemporary demands. This necessitates frequent and strategic updates to keep pace with societal and economic shifts.

In the current era, it is paramount that higher education equips students with robust, practical skills that are directly applicable to their chosen fields. Despite a surge in college enrollment, doubts persist regarding the adequacy of educational preparation for the workforce, particularly in terms of the competencies sought by employers.

As globalization intensifies and the world accelerates, educational institutions must adapt,instilling in students not only technical expertise but also critical thinking, communication prowess, and adaptability. These competencies are essential for thriving in the 21st century.

Moreover, there is an escalating expectation for colleges and universities to champion social responsibility and contribute to sustainable development through innovation. The government of Kerala is taking decisive actions to enhance higher education by establishing commissions to recommend comprehensive policy reforms, regulatory updates, and evaluation system overhauls.

Integral to these initiatives is the restructuring of the undergraduate curriculum, including the FYUGP in BSc Plant Science. This restructuring aims to forge a knowledge-driven society capable of spearheading sustainable development. These changes are designed to ensure that higher education remains relevant, effective, and advantageous for both students and society as a whole.

Dr. K.P. Prasanth,

Chairperson, Board of Studies in UG Botany,

Associate Professor, Department of Botany, Sree Narayana College, Kannur

Preamble

Welcome to the Four-Year Undergraduate Programme (FYUGP) in BSc Plant Science at Kannur University. This curriculum has been meticulously engineered to impart a profound understanding of plant science, arming students with the critical skills necessary to excel in today's demanding and ever-changing environment.

Plant science, the rigorous study of plants, is a field of immense and multifaceted significance, intersecting essential domains such as agriculture, medicine, ecology, and conservation. With the relentless pace of scientific and technological advancements, plant science continually evolves, offering both unprecedented opportunities and formidable challenges. Recent breakthroughs in genome editing, sustainable agriculture, and plant-microbe interactions are revolutionizing our understanding and capabilities in plant science.

Our syllabus is designed to merge deep theoretical knowledge with practical application, providing a robust education that readies students for both advanced academic research and professional careers. Through an intensive mix of classroom lectures, laboratory experiments, fieldwork, and research projects, students will delve into the intricate realms of plant biology.

At Kannur University, we are unwavering in our commitment to fostering an intellectually stimulating environment that promotes curiosity, critical thinking, and a fervor for discovery. We champion active participation, independent thought, and collaborative learning, ensuring our graduates emerge as confident and competent leaders ready to make significant contributions to society.

This syllabus embodies our relentless pursuit of academic excellence, innovation, and continuous improvement. We are dedicated to cultivating a profound appreciation for the natural world and instilling a deep sense of environmental stewardship in our students. Our goal is to shape future leaders who can tackle the pressing challenges facing our planet.

We extend our best wishes to all students embarking on this rigorous educational journey, confident that their time studying plant science at Kannur University will be enriching, rewarding, and transformative.

Academic Competency

In the dynamic field of BSc Plant Science at Kannur University, our graduate attributes bridge academic learning with practical botanical expertise. These attributes encompass a wide range of essential skills and qualities that students develop throughout their studies, ensuring they are well-prepared for real-world applications. Key attributes include critical thinking, enabling students to analyze and evaluate information effectively; problem-solving, fostering creative and practical solutions to botanical challenges; and professionalism, maintaining high standards in work and conduct. Leadership skills guide and inspire others, while teamwork emphasizes the importance of collaboration. Clear and effective communication is crucial for sharing ideas, and a deep understanding of botanical principles underpins all scientific endeavors. Kannur University is dedicated to nurturing these attributes in BSc Plant Science students, seamlessly integrating them into the curriculum. This commitment ensures that graduates are not only knowledgeable in plant science but also resilient, compassionate, and socially conscious leaders ready to excel in their careers and make meaningful contributions to society.

KANNUR UNIVERSITY VISION AND MISSION STATEMENTS

Vision

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasargod and Kannur Revenue Districts and the Mananthavady Taluk of Wayanad Revenue District.

Mission

- To produce and disseminate new knowledge and to find novel avenues forapplication of such knowledge.
- To adopt critical pedagogic practices which uphold scientific temper, theuncompromised spirit of enquiry and the right to dissent.
- To uphold democratic, multicultural, secular, environmental and gender sensitivevalues as the foundational principles of higher education and to cater to the modernnotions of equity, social justice and merit in all educational endeavors.
- To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative and infrastructural standards in such institutions.
- To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with nationalvision and international standards.
- To associate with the local self-governing bodies and other statutory as well asnon-governmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

FYUGP BSc BOTANY AD HOC COMMITTE

1. Prof. S Sudheesh Dean, Faculty of Science, Kannur University
2. Dr. Harikrishnan E, (**Convener**) Assistant Professor of Botany Payyanur College, P O Edat
3. Mr. Falilullahim Aslam K V., Assistant Professor, Department of Botany, Government Brennen College, Thalassery
4. Mr. Muhammed Haneef K A, Assistant Professor, Department of Botany. Government Brennen College, Thalassery
5. Ms. Suvarnika V., Assistant Professor, Department of Botany, Government Brennen College, Thalassery
6. Dr. Biju P., Associate Professor, Department of Botany. Government College Kasaragod
7. Dr. Josekutty EJ, Associate Professor, Department of Botany, Government College, Kasaragod
8. Dr. Tomson Mani, Assistant Professor, Department of Botany, Government Brennen College, Thalassery
9. Dr. P.S Prakash, Associate Professor, Department of Botany. Government Brennen College, Thalassery
10. Dr. Gayatri. R. Nambiar, Asst. Professor, Dept. of Botany, Sir Syed Collage, Taliparamba
11. Dr Prajith PK, Assistant Professor, Department of Botany Nehru Arts and Science College, Kanhangad
12. Dr. P Aparna, Assistant Professor, Department of Botany, Sree Narayana College, Kannur.
13. Ms. Sruthi C.C, Assistant Professor of Plant Science PRNSS College, Mattannur
14. Ms. Resmi P Thomas, Assistant Professor, Department of Botany, Nirmalagiri College, Kuthuparamba.
15. Dr. Ratheesh Narayanan M.K., Assistant Professor, Department of Botany, Payyanur College, Edat
16. Dr. Tajo Abraham, Assistant Professor, Department of Botany, Sir Syed College, Taliparamba

BOARD OF STUDIES IN UG BOTANY

Chairperson

Dr. K.P. Prasanth, Associate Professor, Department of Botany, Sree Narayana College, Kannur

Members

1. Mr. Falilullahim Aslam K V, Assistant Professor, Department of Botany, Government Brennen College, Thalassery
2. Mr. Muhammed Haneef K.A, Assistant Professor, Department of Botany, Government Brennen College, Thalassery,
3. Ms. Suvarnika V, Assistant Professor, Department of Botany, Government Brennen College, Thalassery
4. Ms. Deepa A V, Assistant Professor, Department of Botany, Government Brennen College, Thalassery
5. Dr. Biju P, Associate Professor, Department of Botany, Government College, Kasaragod
6. Dr. R. D. Anpin Raja, Assistant Professor, Department of Botany, Nirmalagiri College, Kuthuparamba
7. Dr. Jeeshna MV, Assistant Professor, Department of Botany, Sree Narayana College, Kannur
8. Dr. Prajith PK, Assistant Professor, Department of Botany, NAS College, Kanhangad
9. Dr. Abdussalam A.K. Assistant Professor, Department of Botany, Sir Syed College, Taliparamba
10. Dr C. Pramod, Assistant Professor, Department of Botany, University of Calicut (Chairperson, PG Board)

PROGRAMME OUTCOMES

PO 1. CRITICAL THINKING

1. Evaluate information objectively to form well-founded judgments.
2. Draw logical conclusions from data, identifying essential details and discarding irrelevant ones for effective problem-solving or decision-making.
3. Detect logical inconsistencies in others' arguments.
4. Analyze data, facts, observable events, and research findings to generate relevant and valid conclusions specific to the field.

PO 2. COMPLEX PROBLEM SOLVING

1. Tackle various challenges in both known and new environments, applying knowledge to practical situations.
2. Analyze problems, develop and implement solutions, and assess their effectiveness.
3. Evaluate the impact of solutions on people and the environment.

PO 3. CREATIVITY

1. Develop innovative content, theories, and methodologies.
2. Use diverse approaches to connect different concepts or events.
3. Provide new insights or improve existing ideas and solutions.
4. Generate, refine, and express new ideas with practical value or inherent significance.

PO 4. COMMUNICATION SKILLS

1. Clearly and effectively communicate ideas or emotions.
2. Use language precisely to convey messages.
3. Engage and captivate the audience skillfully.
4. Listen attentively, understand, and show empathy towards speakers.
5. Express opinions and thoughts with confidence and assertiveness.

PO 5. LEADERSHIP QUALITIES

1. Lead diverse teams effectively and respectfully.
2. Build team unity toward common goals.
3. Motivate and mentor individuals to achieve collective solutions.
4. Offer support and motivation during tough times, promoting resilience and bravery.

PO 6. MASTERING THE ART OF SKILL ACQUISITION

1. Acquire new knowledge and skills, like mastering the ability to learn continuously, through self-directed learning.
2. Independently find and access appropriate resources essential for ongoing learning pursuits.
3. Cultivate organizational skills and time management strategies to set personal goals and deadlines.
4. Cultivate a positive outlook to welcome lifelong learning.

PO 7. EMERGING TECHNOLOGICAL ABILITIES

1. Apply Information and Communication Technology in diverse learning and professional settings, accessing, evaluating, and utilizing various relevant information sources.
2. Utilize appropriate software for data analysis purposes.
3. Understand the risks associated with the digital world and take precautions to ensure security.
4. Uphold constitutional, humanistic, ethical, and moral principles in life, embracing universal values such as truth, integrity, peace, compassion, nonviolence, scientific reasoning, and citizenship responsibilities.
5. Formulate a position or argument on an ethical issue by considering multiple perspectives.
6. Identify ethical dilemmas in professional contexts, adhering to ethical standards by avoiding unethical practices like data fabrication, falsification, plagiarism, and respecting intellectual property rights.
7. Employ impartial, objective, and truthful approaches in all professional endeavors.

PROGRAMME SPECIFIC OUTCOMES

Upon completing the program, graduates will discover a multitude of opportunities, armed with the expertise to excel in their selected field.

PSO 1: The curriculum provides students with a thorough grasp of plant diversity, encompassing topics such as structure, genetics, reproduction, ecology, and economic importance across diverse plant categories. (Programme Outcome Numbers1,6)

PSO 2: Students acquire a broad understanding of plant diversity, exploring the complexities of structure, function, reproduction, and life cycles within specific plant groups, igniting a profound curiosity to delve deeper into the world of plants. (Programme Outcome Numbers 1,2)

PSO 3: In the field of Plant Science, students delve into fundamental principles of Morphology, Taxonomy, Anatomy, Ecology, Physiology, Genetics, and Molecular Biology, while also exploring advanced subjects such as Plant Biotechnology, Molecular Plant Pathogen interactions, and Developmental Botany. (Programme Outcome Numbers 2,6)

PSO 4: Students encounter a wide array of professional pathways, ranging from Landscaping, Gardening, and Floriculture to Organic farming, Herbal technology, Mushroom cultivation, Ecotourism, and Forensic Botany, empowering them to emerge as future entrepreneurs in the field of Plant Science. (Programme Outcome Numbers 3,6,7)

PSO 5: Students develop proficiency in employing diverse analytical techniques and tools for both fundamental and practical research in plant biology, while also addressing intellectual and ethical aspects inherent in biological discoveries. (Programme Outcome Numbers 6,7)

PSO 6: Students acknowledge the essential role of the plant kingdom in human survival and cultivate skills for documenting, conserving, and sustainably managing plant resources in the face of climate change challenges. (Programme Outcome Numbers 6,7,8)

PSO 7: Involvement in project work and research activities encourages students to utilize interdisciplinary concepts, nurturing critical thinking, problem-solving skills, and creativity to innovate and generate new knowledge. (Programme Outcome Numbers 3,6,7)

PSO 8: Practical training across different fields nurtures hands-on skills, mastery in equipment operation, laboratory techniques, and the collection, analysis, and interpretation of biological data. (Programme Outcome Numbers 4,5,6)

PSO 9: Participating in laboratory work and field studies nurtures teamwork and leadership skills among students. Additionally, hands-on field experience provides a practical opportunity for mastering new skills. (Programme Outcome Numbers 5,6,7)

PSO 10: Completing assignments and presentations improves students' communication and ICT skills. Furthermore, coursework in Biostatistics and Bioinformatics offers hands-on experience with software and tools relevant to these areas of biology. (Programme Outcome Number 7)

PSO 11: The flexible curriculum enables instructors to incorporate inquiry-based learning activities, prompting students to inquire, investigate, and draw conclusions independently. This method fosters curiosity, encourages self-directed learning, and enhances understanding of scientific principles. Additionally, teacher-led debates and discussions on controversial scientific topics equip students with argumentation skills, enabling them to support claims with evidence and consider various viewpoints. (Programme Outcome Numbers 5,6,8)

PSO 12: Inspire a lifelong love for learning and professional growth by motivating students to stay abreast of developments in the field of botany, engage in continuing education initiatives, and pursue further studies or certifications when necessary. (Programme Outcome Numbers 4,5,7)

PROGRAMME PATHWAYS WITH PLANT SCIENCE

Sl No	Name of the Pathway	Minimum Requirements
1.	BSc Degree with Single Major in Plant Science	For the THREE YEAR PROGRAMME A minimum of 68 credits from 17 courses and out of these 10 courses above should be above level 300. 2 credits of internship in Plant Science and 24 credits from any 6 disciplines other than the major discipline. For the FOUR YEAR PROGRAMME students should earn a further 32 credits in Plant Science from advance level courses and project and an additional 12 credits from any discipline.
2.	BSc. Degree Major in Plant Science with Minor	A minimum of 24 credits in the minor discipline by the end of Third year and 32 credits by the end of Fourth year in any discipline along with major in Plant Science
3.	BSc Degree Major in Plant Science with Multiple Disciplines	Along with the criteria 4 major discipline in Plant Science, 68 credits from 17 courses along with 12 credits from 3 courses belonging to a maximum of two other disciplines with a total of 24 credits. In the Fourth-year students need to earn an additional 12 credits from any 3 disciplines with a total of 36 credits.
4.	BSc Degree with Plant Science and any other discipline as Major	There is a minimum requirement of 50 percentage credits in Plant Science and a minimum 40 percentage credits from any other disciplines. Students should earn a minimum of 68 credits in Plant Science and 53 credits from another discipline. The double major pathway is not extended to the Fourth year. In the fourth year the required credits from Plant Science or any other major discipline.
5	BSc Degree Major in Plant Science with Vocational Minor	68 credits from 17 courses in Plant Science and in the fourth year they should earn 32 credits in Vocational Minor discipline to get a UG Honours degree with a Vocational Minor
6.	Multidisciplinary UG Programme	The overall fraction of credits should be 70 percentage in the major and minor disciplines. A minimum of 94 credits is required for the Third year programme and a minimum of 124 credits including the project for the Four Year Programme
7.	Inter disciplinary UG Programme	For a Third Year Programme 94 credits from the constituent discipline and for a Four Year Programme124 credits including Project are required.

CONSOLIDATED LIST OF COURSES AND CREDITS REQUIRED FOR BSc BOTANY AND PLANT SCIENCE

Sl. No.	Course Category	3 year UG		4 Year UG	
		Minimum no. of Courses required	Minimum No. of Credits required	Minimum no. of Courses required	Minimum No. of Credits required
1	Major	17	68	22	88
2	Minor (for those with minor pathway)	6	24	8	32
3	MDC	3	9	3	9
4	SEC	3	9	3	9
5	VAC	3	9	3	9
6	AEC	4	12	4	12
7	Internship		2		2
8* (only one type of course from these 4 divisions)	Research project of 12 credits- Mandatory for Honours with research				12
	Project of 12 credits - optional for Honours				12
	Project of 8 credits + one major course (honours)				8 + 4
	Three major Courses instead of optional project				12
9	An additional Course in major/minor/any other discipline			1	4
	TOTAL	**36**	**133**	**47**	**177**

SEMESTER WISE CREDIT DISTRIBUTION OF GENERAL FOUNDATION COURSES FOR BSc PLANT SCIENCE

SL.. No.	Name of the GFC	No. of Courses	Required credits	Distribution among Semesters and Disciplines (*Should select from the list given in the GFC courses of Plant Science)	
1	AEC	4	12	Sem 1	**AEC 1**(English) and **AEC 2** (Hindi/ Malayalam/ Sanskrit/ Kannada/ Urdu/ Arabic, etc.)
				Sem 2	**AEC 3** (English) and **AEC 4** (Hindi/ Malayalam/ Sanskrit/ Kannada/ Urdu/ Arabic, etc.)
2	MDC	3	9	Sem 1	MDC 1
				Sem 2	MDC 2
				Sem 3	MDC 3*
3	VAC	3	9	Sem 3	VAC 1 *
				Sem 4	VAC 2* and VAC 3
4	AEC	3	9	Sem 4	SEC 1*
				Sem 5	SEC 2
				Sem 6	SEC 3
Total		**13**	**39**		

*MDC, VAC and SEC should be related to Horticulture, Plantation Management, Tissue culture and Plant propogation

DETAILS OF MAJOR PATH WAY COURSES IN B.Sc. PLANT SCIENCE									
Sl. No.	Course Code	Sem	Name of the course	Credit	THEORY		PRACTICAL		TOTAL
					ESE	CCA	ESE	CCA	
FIRST YEAR									
Semester 1									
1	KU1DSCPLS101	1	Cell: Structure and Reproduction	3 +1	50	25	15	10	100
Semester 2									
2	KU2DSCPLS102	2	Angiosperm Anatomy, Embryology and Palynology	3+ 1	50	25	15	10	100
SECOND YEAR									
Semester 3									
3	KU3DSCPLS201	3	Diversity of Algae and Bryophytes	3 + 1	50	25	15	10	100
4	KU3DSCPLS202	3	Angiosperm Systematics I	4	70	30	0	0	100
Semester 4									
5	KU4DSCPLS203	4	Diversity of Pteridophytes and Gymnosperms	3 + 1	50	25	15	10	100
6	KU4DSCPLS204	4	Angiosperm Systematics II	3 + 1	50	25	15	10	100
7	KU4DSCPLS205	4	Genetics	3+ 1	50	25	15	10	100

DETAILS OF MAJOR PATH WAY COURSES IN B.Sc. PLANT SCIENCE

Sl. No.	Course Code	Sem	Name of the course	Credit	THEORY		PRACTICAL		
					ESE	CCA	ESE	CCA	TOTAL
THIRD YEAR									
Semester 5									
8	KU5DSCPLS301	5	Mycology and Plant Pathology	3+ 1	50	25	15	10	100
9	KU5DSCPLS302	5	Phytochemistry	3+ 1	50	25	15	10	100
10	KU5DSCPLS303	5	Basics in Molecular biology and Genetics	4	70	30	0	0	100
11	KU5DSCPLS304	5	*Bio-instrumentation and Computers*	4	70	30	0	0	100
12	KU5DSEPLS305	5	*Plantation Management*	4	70	30	0	0	100
13	KU5DSEPLS306	5	*Stress Physiology*	4	70	30	0	0	100
14	KU5DSEPLS307	5	*Weed Ecology*	4	70	30	0	0	100
15	KU5DSEPLS308	5	*Seed Technology*	4	70	30	0	0	100
Semester 6									
16	KU6DSCPLS309	6	Biotechnology and Basic Bioinformatics	3 + 1	50	25	15	10	100
17	KU6DSCPLS310	6	Phytophysiology	3+ 1	50	25	15	10	100
18	KU6DSCPLS311	6	Plant Ecology and Phytogeography	3+ 1	50	25	15	10	100
19	KU6DSCPLS312	6	*Evolution and Plant Breeding*	4	70	30	0	0	100
20	KU6DSCPLS313	6	*Research Methodology and Biostatistics*	4	70	30	0	0	100
21	KU6DSEPLS314	6	*Floriculture and Olericulture*	4	70	30	0	0	100
22	KU6DSEPLS315	6	*Agroecology*	4	70	30	0	0	100
23	KU6DSEPLS316	6	*Ethnobotany*	4	70	30	0	0	100
24	KU6DSEPLS317	6	*Pharmacognosy and Phytochemistry*	4	70	30	0	0	100
25	KU6INTPLS318	6	Internship/apprenticeship/ Field trip/ Nature Camp	2	35	15	0	0	50

DETAILS OF MAJOR PATH WAY COURSES IN B.Sc. PLANT SCIENCE

Sl. No.	Course Code	Sem	Name of the course	Credit	THEORY		PRACTICAL		TOTAL
					ESE	CCA	ESE	CCA	
FOURTH YEAR									
Semester 7									
26	KU7DSCPLS401	7	Advanced course in Plant Developmental Biology	4	70	30	0	0	100
27	KU7DSCPLS402	7	Advanced course in Cryptogamic Diversity	3+ 1	50	25	15	10	100
28	KU7DSCPLS403	7	Advanced course in Diversity of Phanerogams	3+ 1	50	25	15	10	100
29	KU7DSCPLS404	7	Advanced course in Mycology, Microbiology and Plant pathology	4	70	10	0	20	100
30	KU7DSCPLS405	7	Modern tools and Techniques for Ecological Studies	4	70	10	0	20	100
Semester 8									
31	KU8DSCPLS406	8	Advanced Bioinformatics	3+ 1	50	25	15	10	100
32	KU8DSCPLS407	8	Phytogeography of North Kerala	4	70	30	0	0	100
33	KU8DSCPLS408	8	Applications of Botany in Industries - North Kerala	3+ 1	50	25	15	10	100
34	KU8DSEPLS409	8	*Advanced course in Angiosperm Systematics*	4	70	30	0	0	100
35	KU8DSEPLS410	8	*Plant Microtechnique*	4	70	30	0	0	100
36	KU8DSEPLS411	8	*Nanobiotechnology*	4	70	30	0	0	100
37	KU8DSEPLS412	8	*Climate change and Disaster Management*	4	70	30	0	0	100
38	KU8DSEPLS413	8	*Environmental Impact Assessment and Conservation Management*	4	70	30	0	0	100
39	KU8DSEPLS414	8	*Structural biology*	4	70	30	0	0	100
40	KU8PRJPLS415	8	Project (A project of 8 credits +1 Major course or 3 Major courses instead of optional project. The scheme of evaluation of the project of 8 credits will 140 +60 = 200)	12	210	90		0	300

DETAILS OF MINOR PATHWAY COURSES IN BOTANY / PLANT SCIENCE

Sl. No.	Course Code	Sem	Name of the course	Credit	THEORY		PRACTICAL		TOTAL
					ESE	CCA	ESE	CCA	
Semester 1									
41	KU1DSCBOT103	1	Diversity of Plants I	3 + 1	50	25	15	10	100
42	KU1DSCBOT104	1	Plant Ecology and Phytogeography	3+ 1	50	25	15	10	100
Semester 2									
43	KU2DSCBOT105	2	Reproduction and Life Cycle of Plants	3+ 1	50	25	15	10	100
44	KU2DSCBOT106	2	Angiosperm Taxonomy and Morphology	3 + 1	50	25	15	10	100
Semester 3									
45	KU3DSCBOT206	3	Diversity of plants II	3+ 1	50	25	15	10	100
46	KU3DSCBOT207	3	Angiosperm Anatomy and Embryology	3+ 1	50	25	15	10	100
47	KU3DSCBOT208	3	Forest Botany	3+1	50	25	15	10	100
Semester 6									
48	KU6DSCBOT321	6	Mycology, Phytopathology and Applied Botany	3+ 1	50	25	15	10	100
49	KU6DSCBOT322	6	Evolution of Plants and Animals	4	70	30	0	0	100
50	KU6DSCBOT323	6	Plantation Management	3+ 1	50	25	15	10	100
51	KU6DSCBOT324	6	Forest Botany	3+ 1	50	25	15	10	100
52	KU6DSCBOT325	6	Ethnobotany	3+ 1	50	25	15	10	100
53	KU6DSCBOT326	6	Herbal Science	3+ 1	50	25	15	10	100
54	KU6DSCBOT327	6	Modern Plant Pathology	3+ 1	50	25	15	10	100
55	KU6DSCBOT328	6	Horticulture	3+ 1	50	25	15	10	100
56	KU6DSCBOT329	6	Agronomy and Agroforestry	3+ 1	50	25	15	10	100

DETAILS OF FOUNDATION COURSES IN BOTANY / PLANT SCIENCE

Sl. No.	Course Code	Sem	Name of the course	credit	THEORY		PRACTICAL		TOTAL
					ESE	CCA	ESE	CCA	
1	KU1MDCBOT101	1	Plant diversity	3	50	25	0	0	75
2	KU1MDCBOT102	1	Botany for the Beginners	3	50	25	0	0	75
3	KU2MDCBOT103	2	Beginner's exploration to the world of leaves and flowers	3	50	25	0	0	75
4	KU2MDCBOT104	2	Agrobiodiversity	3	50	25	0	0	75
5	KU3MDCBOT105	3	Botanical Art	3	50	25	0	0	75
6	KU3MDCBOT106	3	Introductory course on Applications of Botany	3	50	25	0	0	75
7	KU3MDCBOT107	3	Microscopy and visualisation tools in Biology	3	50	25	0	0	75
8	KU4SECBOT108	4	Biodiversity of Kerala and Ecotourism	3	50	25	0	0	75
9	KU4SECBOT109	4	Floral art Business	3	50	25	0	0	75
10	KU4SECBOT110	4	Entrepreneurship in Botany	3	50	25	0	0	75
11	KU4SECBOT111	4	Gardening Indoor and Outdoor	3	50	25	0	0	75
12	KU4SECBOT112	4	Medicinal Plants of Kerala	3	50	25	0	0	75
13	KU4SECBOT113	4	Mushroom Cultivation and Marketing	3	50	25	0	0	75
14	KU4SECBOT114	4	Plant Tissue culture Lab set up for commercial Production	3	50	25	0	0	75
15	KU5SECBOT115	5	Basics of Anthurium and Orchid Cultivation	3	50	25	0	0	75
16	KU5SECBOT116	5	Mangrove and Laterite Hill Ecology for Tourism	3	50	25	0	0	75
17	KU5SECBOT117	5	Plantation Crop Nursery Setup Management	3	50	25	0	0	75
18	KU5SECBOT118	5	Hydroponics and Aquaponics	3	50	25	0	0	75
19	KU5SECBOT119	5	Plant Propagation Methods	3	50	25	0	0	75
20	KU3VACBOT120	3	Gender: A Biological perspective	3	50	25	0	0	75
21	KU3VACBOT121	3	Sustainable Life style	3	50	25	0	0	75
22	KU3VACBOT122	3	Conservation Biology	3	50	25	0	0	75
23	KU4VACBOT123	4	Basics of Environmental Science	3	50	25	0	0	75
24	KU4VACBOT124	4	Climate Change and Disaster Management	3	50	25	0	0	75
25	KU4VACBOT125	4	Entrepreneurship in Compost Making	3	50	25	0	0	75
26	KU4VACBOT126	4	Biofertiliser and marketing	3	50	25	0	0	75
27	KU6VACBOT127	6	Agribased Microenterprises	3	50	25	0	0	75
28	KU6VACBOT128	6	Indigenous plants: their Identification and utility	3	50	25	0	0	75
29	KU6VACBOT129	6	Wetland and Laterite Hill Ecology	3	50	25	0	0	75
30	KU6VACBOT130	6	Apiculture	3	50	25	0	0	75

GENERAL RULES

ELIGIBILITY FOR ADMISSION AND SELECTION OF COURSES

Admission, enrollment, registration, options for changing major programs, selection of academic pathways, readmission and scheme migration, assessment and evaluation, and final grading and awarding of degrees are based on the Kannur University FYUGP Regulations and Curriculum Framework 2024, as well as the norms and rules established by the Government and the University from time to time.

Students must have completed the examination conducted by a recognized Board or University at the +2 level of schooling or its equivalent. Departments will provide information on the courses they offer, including the eligibility criteria.

At the end of the second semester, students may be permitted to change their major program of study. Based on the availability of seats and infrastructure facilities, students may opt for any discipline they studied during the first two semesters as discipline-specific foundation courses or multidisciplinary foundation courses. If a student switches their major to a discipline in which an MDC has been completed, they will have to undertake additional DSC courses in the new discipline to acquire the required minimum credits.

One course should be offered by a faculty member whenever possible. The faculty member shall inform the students about the outcomes, course plan, and assessment methods at the beginning of the course.

Module 5 of each course is designated as 'Teach Space'—a personal, flexible, and dynamic area for teaching activities tailored to the needs of the instructor, infrastructure, course outcome, and the requirements of the students.

Students are advised to select a variety of courses from the available options instead of choosing courses with similar content. Some professional courses and jobs require a Botany/Plant Science major along with minors in Chemistry and Zoology. Therefore, students should carefully consider their selection of major and minor courses.

SWAYAM, MOOC, or other online courses can be selected from the course offerings of Indian universities and institutes. These courses must be related to the student's major and can be used to earn credits. Students can opt for SWAYAM and other online courses to earn credits, provided they complete an internal viva, give a presentation, and submit a report on the course.

SUGGESTED PEDAGOGY AND EVALUATION

Teaching-Learning

The FYUGP program is based on Outcome-Based Education (OBE). To achieve the desired outcomes in each course, various methods of teaching, learning, and evaluation are employed. Credit earning and transfer follow the guidelines of the Kannur University FYUGP regulations and curriculum framework of 2024.

Types of Teaching and Learning Activities

Types of Course	Teacher Activity	Student Activity
Theory	Lectures, demonstrations, presentations, discussions, and debates	Review of literature, assignments, presentations, e-learning, discussions, and debates with peers, teachers, and experts.
Practical	Demonstrations, experimentation, field visits, and certification	Identification, comparison, differentiation, and categorization of different plants and their parts using permanent slides and hand sectioning. Additionally, demonstration, experimentation, field visits, report writing, and record keeping
Field Study/Study Tour	For plant diversity and technological studies, experiential learning should complement theoretical learning. Faculty members guide this flexible activity, determining the field for the trip.	Students should observe the features from the field and document peculiarities and diversity in a report.

Internship

Each student must complete an internship within the six semesters to engage with practical aspects of their learning and enhance employability. A report is required by the end of the sixth semester. The internship must last a minimum of 60 working hours and can be on-campus or off- campus, potentially consisting of 1-3 accumulated activities. Off-campus internships require prior approval, and an attendance certificate must be submitted to the HoD upon rejoining. HoDs ensure completion of the internship.

Suggested Internships: Summer internships at biology institutes or local industries related to botany/ecology/agriculture, field trips to various ecosystems or nature camps, apprenticeships in NGOs or relevant industries, and social responsibility activities such as river restoration, PBR preparation, landscaping, and green auditing.

Student Responsibilities: Selecting the internship topic/activity, discussing with a mentor, planning and execution, and preparing and presenting the report.

Teacher/Supervising Guide Responsibilities: Confirming the topic/activity, providing guidance, and correcting and certifying the prepared report.

Mandatory/Optional Project

In the eighth semester, a mandatory 12-credit project (minimum 360 working hours) is required for FYUGP research or honors, or an optional 8-credit project (minimum 240 working hours) alongside a major theory course. Project guidance can be provided by a faculty member of the department. If necessary, the expertise of an external guide may be utilized. Facilities and expertise for the project can be on-campus or off-campus, with required permissions for off-campus projects. Students must maintain and submit a project log book/register along with the final report.

Student Responsibilities: Suggesting the topic, discussing with the project guide and peers, reviewing literature, planning and designing the project, experimentation, data analysis, and preparing and presenting the project report.

Teacher/Supervising Guide Responsibilities: Confirming the topic, demonstrating, planning experimentation, providing guidance, and correcting and certifying the project.

Evaluation

Each student should go through the evaluation process in an indirect grading method, as per the Kannur University FYUGP- regulations and curriculum frame work.- 2024. The evaluation for the odd semesters and the practical components will be done by the college itself and that for even semesters will be conducted at the university level.

Regarding evaluation, one-credit courses will be assessed for 25 marks, two-credit courses for 50 marks, three-credit courses for 75 marks, and four-credit courses for 100 marks. A copy of all records of evaluation shall be maintained in the department/college and should be available for verification by the university/BoS / the student.

EVALUATION	WEIGHTAGE
END SEMESTER EVALUATION- ESE	70
CONTINUOUS COMPREHENSIVE ASSESSMENT - CCA	30

The CCA component has two parts Formative Assessment (FA) and Summative Assessment (SA) with an equal weightage. The components of Evaluation will be determined by the instructor/faculty and the same will be communicated to the student at the beginning of the course.

Suggestive Methods of Formative Assessment (FA)

Formative assessment methods may include assignments (both theory and practical), viva voce, quizzes, interviews, presentations, classroom discussions, observation of practical skills, and self and peer assessments. The course coordinator or faculty member will determine the combination of these tools and their respective weightages and will communicate this information to the students at the beginning of the course.

Suggestive Methods of Summative Assessment (SA)

SA methods may include written tests, open-book tests, laboratory records or reports, project reports, and case study reports. The coordinator can decide on the combination and relative weightage of these tools, which should be communicated to the students at the beginning of each course.

Evaluation of Theory Courses

End Semester Examinations will be held in October for odd semesters and in March for even semesters. A 3-credit theory course will be evaluated with a 50-mark question paper, with a duration of 1.5 hours. A 4-credit theory course will be evaluated with a 70-mark question paper, with a duration of 2 hours.

A copy of all records of evaluation shall be maintained by course in charge or the faculty for verification by the HoD / the student.

Evaluation of Practical Courses

Students must attend the practical classes and go through the continuous evaluation process for the course. Only those who have completed the continuous evaluation will be permitted to appear for the end-semester (practical) viva-voce. A copy of all records of evaluation shall be maintained by course in charge or the faculty for verification by the HoD / the student.

The end-semester practical examination, viva-voce, and evaluation of practical records shall be conducted by the course in-charge and an internal examiner appointed by the Department Council. The Continuous Comprehensive Assessment (CCA) of practical courses shall be conducted by the course in-charge. For courses with both theory and practical components, the CCA components: The continuous evaluation of practical courses shall be completed at least 10 days before the start of the end-semester examination.

EVALUATION	**WEIGHTAGE**
END SEMESTER EVALUATION- ESE	60
CONTINUOUS COMPREHENSIVE ASSESSMENT - CCA	40

Internship

The components of internship evaluation include performance evaluation, attendance and participation, the quality of the internship report, and the effectiveness of the presentation. Additional components are the viva voce examination, feedback from the internship site, self-assessment, and, if applicable, peer assessment. Continuous Comprehensive Assessment (CCA) will be conducted by the faculty in charge, while the End Semester Examination will be evaluated by the Department Council, excluding the faculty in charge.

Components of Evaluation of Internship	Weightage Marks	Marks for Internship 2 Credit/50
Continuous Comprehensive Assessment (CCA)	30%	15 (Report 5, Viva 5 , Presentation 5)
End Semester Evaluation (ESE)	70%	35

Evaluation of Project

A student pursuing UG Honours with research must complete a mandatory research project worth 12 credits by the end of the eighth semester. For other UG Honours students, the project is optional. Since each credit corresponds to 25 marks, the 12-credit project will be evaluated for a total of 300 marks. The evaluation scheme for the project is detailed below:

Project type	Maximum Marks	CCA (30%)	ESE (70%)
Research Project of 12 Credits	300	90 Pre synopsis presentation and viva Review of literature Regularity and Participation (1:1:1)	210 Report, Methodology, Social Relevance, Scientific accuracy, innovation, data analysis, presentation skill ,viva (components and their relative weightage can be decided by the department council)
Research Project of 8 Credits	200	60 Pre synopsis presentation and viva Review of literature Regularity and Participation (1:1:1)	140 Report, Methodology, Social Relevance, Scientific accuracy, innovation, data analysis, presentation skill ,viva (components and their relative weightage can be decided by the department council)

***The question paper design and model question papers will be added later**

Grading

Marks obtained in each component or question of a course are converted into a 10-point indirect grading system. The Semester Grade Point Average (SGPA) is calculated from these grades to evaluate student performance each semester. The Cumulative Grade Point Average (CGPA) and the corresponding grading scale are outlined below.

Sl. No	Percentage of Marks (ESE and CCA put together)	Description	Letter Grade	Grade Point (P)	Range of Grade Points
1	95% and above	Outstanding	O	10	9.50 – 10
2	Above 85% and below 95 %	Excellent	A+	9	8.50 – 9.49
3	Abo vxcccccc ve 75% to below 85%	Very Good	A	8	7.50 – 8.49
4	Above 65% to below 75%	Good	B+	7	6.50 – 7.49
5	Above 55% to below 65%	Above Average	B	6	5.50 – 6.49
6	Above 45% to below 55%	Average	C	5	4.50 – 5.49
7	Above 35% to below 45% (CCA and ESE put together) with a minimum of 30% in ESE.	Pass	P	4	3.50 – 4.49
8	Below an aggregate of 35% or below 30% in ESE	Fail	F	0	0 – 3.49
9	Not attending the examination	Absent	Ab	0	0

1	CELL: STRUCTURE AND REPRODUCTION	KU1DSCPLS101
Semester : I **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Knowledge in the basic structural and functional unit of life, the cell.
CO2	Understanding of the cell biology related terms used in the description of diverse forms of life.
CO3	Understanding the basic differences in cell structure and cell reproduction that exist in various plant groups.
CO4	Ability to apply the concepts gathered in the field of evolution and diversity studies.
CO5	Firsthand experience in viewing cells under microscope and there by induction of enthusiasm in biological studies.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√		√							
CO3					√				√			
CO4							√		√			
CO5											√	√

Course Description
This is an introductory biology course designed for UG students in general and BSc Botany and Plant Science in particular. The aim of the course is to give basic knowledge about the structure and function of cells and cellular components with historical and evolutionary perspectives.
• *First module gives the brief history of the development of cell biology and evolution of cells.* • *Second module gives an account on the cellular envelopes and nucleus.* • *Third module is packed with endo-membrane system and other cellular organelles.* • *Fourth module will give you in-depth knowledge on cell cycle and division, different phases of Mitosis and Meiosis.*
This course will also provide you opportunities to observe diverse cells and hands-on training to identify stages of mitosis and meiosis during laboratory sessions.

Course Objectives:

1. To gather knowledge on evolution of cell biology as a discipline.
2. To understand the diversity in structure and function of cells and cell components.
3. To understand the stages of cell reproduction- mitosis and meiosis as well as the significance of these processes in sustenance and evolution of species.
4. To get hands on training in observing various types of cells under microscope.

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. INTRODUCTION TO CYTOLOGY (5 Hrs)

1.1. History - History of the progress of cell biology and development of cell theory.
1.2. Cell as a unit of structure and function. Levels of organization of cells up to organism.
1.3. Origin and Evolution of cell. Characteristics of prokaryotic and eukaryotic cells.
1.4. Modern concept on cell components- Cellular envelopes, Protoplasm, Cell organelles, Cytoplasm, Non living inclusions.

Module 2. CELLULAR ENVOLOPE AND NUCLUEUS (10 hrs)

2.1. Cellular envelopes- Types and functions
2.2. Cell wall - Chemistry, Ultra structure and function of Plant cell wall. Thickening of cell wall, Pits and pit apertures, Plasmodesmata. Cytoplasm- Physical, chemical and biological properties.
2.3. Cell membrane - Overview of fluid mosaic model; Chemical composition of membranes; membrane function.
2.4. Nucleus - Ultra structure of the interphase nucleus, The nuclear envelope; Nuclear pore complex, Nucleolus - Structure and functions.

Module 3. CELL ORGANELLES (15 hrs)

3.1. Endomembrane system - Endoplasmic Reticulum; Golgi Apparatus; Lysosomes. Vacuole. Phagocytosis and Pinocytosis and Membrane transport
3.2. Plastids – Types of plastids. Structure and function of Chloroplast and Mitochondria. Significance of Mitochondria and Chloroplast in evolutionary biology and molecular taxonomy. Endosymbiotic Theory.
3.3. Microbodies- Structure and functions of Peroxisomes, Glyoxysomes and Ribosomes.
3.4. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Major nonliving inclusions in the plant cell.

Module 4. CELL CYCLE AND CELL REPRODUCTION (15 hrs)

4.1. Concept of cell Cycle: Phases of eukaryotic cell cycle -Interphase and Mitotic Phase.
4.2. Mitosis: Karyokinesis and Cytokinesis. Different Stages in Karyokinesis – Prophase, Metaphase, Anaphase and Telophase. Significance of mitosis. Cytokinesis – Cytoplasmic division in Plant cell. Types of mitosis.
4.3. Meiosis: Stages of Meiosis I and II- both karyokinesis and cytokinesis.Variations among plants. Significance of Meiosis.
4.4. Comparative account of Mitosis and Meiosis among different organisms- Gametic meiosis and Zygotic meiosis.

Module 5. Teach Space (15 hrs): This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Compound microscope and its parts.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Crinum*/*Rheo*.
3. Diversity of cells- prokaryotic (blue green alga), eukaryotic (*Chlorella*, *Spirogyra*, stomata of different leaves, Trichomes).
4. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf, *Vallisnaria*.
5. Mitosis using Onion root smear.
6. Demonstration of staining of organelles/ animal/ plant/ microbial cells for light microscopic observation
7. Demonstration of meiosis using flower buds or any other suitable specimen.
8. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics

1. Geological time scale
2. Theories and experiments on evolution of life- classical and modern
3. Types of models of plasma membrane
4. Significance and applications of membrane studies in immunology, medicine , drug designing etc.
5. Meiotic errors and syndromes in human beings and plants
6. Evolution of crop plants and significance of meiosis and mitosis.

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco, 2009	1, 2, 3,4
2	Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.,2009	1, 2, 3, 4

3	De Robertis E.D. and De Robertis E.M.F. Cell and Molecular Biology 8th Edition. Lee and Fab International edition, Philadelphia.2017.	1, 4
4	Pawar, Cell Biology, Himalaya Publishing House, Mumbai. 2019.	1, 2,3, 4
5	Rastogi, S.C. Cell and Molecular Biology. New Age International Publishers, New Delhi. 2016	1, 2, 3, 4
6	Verma P.S. and Agarwal V.K. Cell Biology (Cytology, Biomolecules, Molecular biology),Paper back, S.chand and Company .Ltd. 2016.	2, 4
Core Compulsory Readings		
1	Karp, G. (2010), Cell Biology, John Wiley & Sons, U.S.A. 6th edition.	
2	Lodish, H. Berk A, Zipursky SL, et al., 2000: Molecular Cell Biology, 4th edition., W.H. Freeman, New York.	
Core Suggested Readings		
1	http://ndl.iitkgp.ac.in/document/eXF1YzdhQ2RxM3hPUm8ra0k0NHZGUT09	
2	http://ndl.iitkgp.ac.in/document/SFBhRUg0cDg3MTJyRXE0OVB5RkpLZz09	

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question

- ➢ What are the two main types of cells, and what distinguishes them from each other?
- ➢ Explain the fluid mosaic model of the cell membrane and its significance in cell biology.
- ➢ What are the phases of the eukaryotic cell cycle, and what happens during each phase?
- ➢ How does protoplasmic streaming contribute to cellular functions in plants?
- ➢ Define cytokinesis and describe its role in cell division.

3 Marks Questions (Applying and Analyzing):

- ➢ Using a diagram, illustrate the structure of a plant cell wall and explain its functions.

- Compare and contrast the structure and function of mitochondria and chloroplasts.
- Design an experiment to demonstrate the process of phagocytosis in cells.
- Analyze the implications of the endosymbiotic theory for our understanding of cellular evolution.
- Propose a hypothesis to explain the possible evolutionary line of three cells- A- prokaryotic cell autotrophic, B- prokaryotic heterotrophic and C- eukaryotic autotrophic.
- Give an illustrated self- explanatory diagram of prokaryotic and eukaryotic cells, indicating their primary structural differences.

5 Marks Questions (Evaluating and Creating):

- Evaluate the significance of mitosis in the growth and development of multi-cellular organisms.
- Design an educational poster illustrating the stages of meiosis and explaining their importance in sexual reproduction.
- Critically evaluate the role of the endomembrane system in protein synthesis and trafficking within cells.
- Develop a model to demonstrate the role of the cytoskeleton in maintaining cell shape and facilitating cell movement.
- Evaluate the impact of advancements in cell biology on modern scientific research and technology.

Employability for the Course / Programme

It is one of the basic courses which is very helpful in understanding the fundamental concepts in biology as well as in daily life

2	ANGIOSPERM ANATOMY, EMBRYOLOGY AND PALYNOLOGY	KU2DSCPLS102
Semester : II Hrs/week : 3 Theory + 1 Practical		Credits : 4

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
C01	Knowledge in the internal structure of angiosperm.
C02	Understanding of the anatomical, palynological and embryological related terms used in the description of diverse forms of life.
C03	Understanding the variations in the internal structure and reproduction that exist in various plant groups.
C04	Interpret the adaptive and protective mechanisms exhibited by plants in response to various environmental conditions.
C05	Ability to apply the concepts in the field of evolution and diversity studies.
C06	Firsthand experience in viewing cells under microscope and there by induction of enthusiasm in biological studies.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√		√									
CO2		√			√							
CO3							√	√				
CO4											√	√
CO5				√					√			
CO6											√	√

Course Description
The course offers a thorough exploration of plant biology- angiosperm anatomy, embryology, palynology. Students get theoretical and practical knowledge about various plant tissues, tissue systems present in various plant organs; along with secondary growth of root and stem. Additionally, the course gives insights into various terms and stages in embryology, fertilization mechanisms.
• *First module brings the knowledge of tissues and tissue systems in angiosperms* • *Second module gives an account on structure of primary plant body and its secondary growth.* • *Third module is packed with pre fertilisationsal stages relevant in the embryology of angiosperms.* • *Fourth module gives in-depth knowledge on embryo formation, structure and variations.*
This course will also provide opportunities for intense laboratory sessions to observe diverse tissues and tissue systems present in plants.

Course Objectives:

1. Understand plant tissue classification, structure, and functions.
2. Explore plant anatomy, including primary structures and tissue systems.
3. Study plant reproduction mechanisms and embryology.
4. Develop practical skills in observing and analyzing plant structures and tissues.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Plant Tissues and Tissue Systems (12 hours)

1.1. Introduction to plant tissues and their classification. Meristems and Permanent Tissues. Classification, distribution, structure, and function of meristems.
1.2. Theories explaining the growth and development of plant structures from meristem. Histogen theory, Tunica Corpus Theory. Developmental processes of the plant body: root apex, vegetative shoot apex, floral apex.
etc.
1. 3. Occurrence, structure and functions of simple tissues: Parenchyma, Collenchyma, Sclerenchyma. Complex tissues: Xylem and Phloem. Special tissues- Types of secretory tissues: digestive glands, glandular hairs, nectaries,
1.4. General Account of Epidermal tissue system, Ground tissue system and Vascular System.
- Types of Stomata- monocot and Dicot; different types of vascular bundles- Radial, Conjoint, Collateral- open and closed, Bicollateral.

Module 2. Structure of Plant Body (15 hours)

2.1. Anatomy of primary structures: roots, stems, and leaves in dicots and monocots with a comparative account. Nodal Anatomy- Types of nodes and Evolutionary trend. Anatomy of Abscission zone. Floral anatomy and mechanisms of flower development.
2.2. Processes and structures involved in secondary growth: distribution, structure and

function of stelar cambium and extra-stelar cambium. Secondary growth in dicot stem root. Seasonal variation in cambial activity and its implications on wood formation. Heartwood and sap wood. Spring wood and Autumn Wood.

2.3. Anomalous Secondary growth- A general account on types of anomalies. Unusual patterns of secondary growth in *Dracaena, Bignonia* and *Boerhaavia*.

2.4. Anatomical adaptations in xerophytes, halophytes, epiphytes, hydrophytes.

Module 3. Sporogenesis, Gametophyte formation and Pollination (10 hours)

3.1. Introduction to Angiosperm Embryology and Palynology**:** Historical overview of embryology and its significance. Various techniques in Embryology and Palynology. General account on pollen structure and morphology. Applications of Embryology and Palynology.

3.2. Structure and functions of microsporangium and its wall layers. Pollinia. Microsporogenesis- process, types and male gametophyte development. Megasporogenesis: process and significance in female gametophyte development.

3.3. Structure and functions of megasporangium- Types of ovules. Megasporogenesis- process, types and female gametophyte development. Monosporic, Bisporic and Ttrasporic; detailed structure of Polygonum type of Embryosac.

3.4. Pollination- Types of Pollination- Self Pollination and Cross Pollination. Significance of Cross Pollination. Different Mechanisms of pollination. Basic concept of self-incompatibility. Economic and Evolutionary significance of Pollination.

Module 4. Fertilization and Embryogenesis (8 Hrs)

4.1. Pollen tube formation and fertilization: Processes and significance. Types of pollen tube entry- Porogamy, Chalazogarmy and mesogamy.

4.2. Double Fertilization and triple fusion- processes and significance. Structure, development, and types of endosperms.

4.3. Development of Embryo in Dicots and Monocots with major substages. Structure of mature dicot and monocot embryos.

4.4. Apomixis and Amphomixis. Classification and significance of polyembryony. Brief account on Experimental Embryology.

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Module 5. Teach Space (15 hrs):

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Observation of apical meristems in root and stem.
2. Microphotographs of different types of tissues- Parenchyma- Aerenchyma, Chlorenchyma (Spongy, Palisade),

Collenchyma, Sclerenchyma, Xylem and Phloem
3. Microphotographs of different types of tissue systems- trichomes, stomata- Anomocytic, Paracytic, Diacytic and Anisocytic.
4. Primary structures in dicot stem (*Centella*), root (*Tinospora*), and leaf (*Ixora*) and monocot stem (Grass), root (*Colocasia*), and leaf (Grass).
5. Secondary Structures in Dicot root (*Tinospora, Ricinus*) and Stem (*Eupatorium/Vernonia* and *Tinospora*)
6. Anomalous secondary thickening in *Boerhaavia* stem.
7. Acetolysis of Pollengrains - *Hibiscus*
8. TS of Mature anther- *Datura, Ixora*
9. Observation of Pollinia- *Calotropis*/ Orchids
10. Embryos of Monocots and Dicots

Suggested Assignments – Theory

1. Different theories on meristem
2. Different types of nodes with examples
3. Root stem transition with examples
4. Biochemical changes that happen during abscission
5. Anomalous secondary thickening in various climbers and herbs and shrubs
6. Types of anthers with examples
7. Variations in Pollen morphology
8. Anatomy and taxonomy
9. Anatomy and Evolution
10. Polyembryony and Apomixis with examples and relevance
11. Production of fruits without pollination/seeds

Suggested Assignments – Practical

1. Different types of nodes with examples
2. Root stem transition with examples
3. Anomalous secondary thickening in various climbers and herbs and shrubs
4. Types of anthers with examples
5. Variations in Pollen morphology
6. Pollen calendar preparation
7. Aeropalynology- survey

Suggested readings specific to the module.		
Sl. No	Title/Author/Publishers of the Book specific to the module	Module No.
1	Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Pub. House. Delhi. 5th edition.	3, 4
2	Dutta, A. C. (2019). Botany for Degree Students. Oxford University Press.	1, 2, 3, 4
3	Esau, K. (1953). Plant Anatomy. John Wiley & Sons.	1, 2

4	Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands	3, 4
5	Pandey, B. P. (2009). Plant Anatomy and Embryology. S. Chand & Company Ltd.	1, 2, 3, 4
6	Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Pub. Co. Pvt. Ltd. Delhi.	3
7	Tripathi, R. D. (2018). Introduction to Plant Anatomy. Rastogi Publications	1, 2
Core Compulsory Readings		
1	Fahn, A. (1990). Plant Anatomy. Pergamon Press.	
2	Kaur, R., & Singh, J. (2019). Practical Plant Embryology. S. Chand Publishing.	
3	Mauseth, J. D. (2012). Plant Anatomy and Development. Jones & Bartlett Learning	
4	Singh, S., & Singh, P. K. (2015). Textbook of Embryology. CBS Publishers &Distributors Pvt. Ltd	
Core Suggested Readings		
1	O'Brien, T. P., & McCully, M. E. (1981). Introduction to Plant Anatomy. Academic Press.	
2	Mauseth, J. D. (2012). Plant Anatomy: An Applied Approach. Jones & Bartlett Learning.	
3	Irish, V. F. (2009). Plant Development and Evolution. Wiley-Blackwell.	
4	Taiz, L., & Zeiger, E. (2010). Principles of Plant Physiology. Sinauer Associates, Inc.	

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. Explain the structural characteristics of Parenchyma tissue and its role in plant physiology.
2. Differentiate between conjoint and collateral vascular bundles,

highlighting their significance in plant structure and function.
3. Define the term "hydathodes" and discuss their role in plant water management.
4. Describe the structure of the root apex in dicot plants and its importance in root development.
5. Compare and contrast the anatomy of monocot and dicot leaves, emphasizing their structural differences.

3 Marks Questions:

1. Discuss the functions of secretory tissues in plants and provide examples of plant organs where they are found.
2. Analyze the process of microsporogenesis and its significance in plant reproduction.
3. Explain the mechanism of self-incompatibility in plants and its implications for pollen- pistil interactions.
4. Compare the structures of dicot and monocot embryos, highlighting their developmental differences.
5. Evaluate the importance of endosperm in seed development, citing examples of different types of endosperm.

5 Marks Questions:

1. Describe the process of double fertilization in angiosperms, including the events occurring during each fertilization event.
2. Discuss the structure and functions of the vascular cambium in secondary growth of roots and stems.
3. Analyze the adaptive features of xerophytes and hydrophytes, illustrating how their anatomical structures enable them to thrive in their respective habitats.
4. Explain the significance of pollen allergy in human health and its ecological implications.
5. Compare and contrast the primary and secondary structures of dicot stems, highlighting their differences in tissue composition and organization.

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Employability for the Course / Programme

It is one of the basic courses with intense practical exercises involving the observation of plant structures and tissues; thereby provides a solid foundation in plant biology essential for careers in botany, agriculture, and pharmacognosy.

3	Diversity of Algae and Bryophytes	KU3DSCPLS201
Semester : 3 **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English
3. Completed the basic foundation courses in the first two semesters

Course Outcomes	
CO1	Acquisition of basic knowledge in the diversity among plants, especially algae and bryophytes.
CO2	Understanding of the life cycles in algae and bryophytes.
CO3	Understanding the basic differences that exist among different selected genera of algae and bryophytes..
CO4	Ability to apply the concepts gathered in this course to the field of evolution and ecological studies.
CO5	Firsthand experience in viewing the diversity in algae and bryophytes using laboratory procedures. .

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2	√				√							
CO3						√	√					
CO4											√	√
CO5								√	√			

Course Description
This is a major intermediate course designed for BSc Botany students. The aim of the course is to give basic knowledge about the diversity of algae and bryophytes..
• *First module gives a general idea on Algal classification.* • *Second module gives details on the structure and life cycle of model organisms from selected algal taxa.* • *Third module gives a general account on classification of bryophytes* • *Fourth module is a detailed account on selected bryophytes.*
This course will also provide you opportunities to observe diverse cells, tissues and organs of algae and bryophytes, through the practical sessions on model organisms.

Course Objectives:

1. To expertise in collection, preservation and studies in algae and bryophytes.
2. A comparative knowledge of lower plants.
3. Skill development in for proper description, identification and classification through morphological, anatomical and life cycle studies
4. Consciousness on the origin and evolution of lower groups of plants.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Taxonomy of Algae (10 hrs)

1.1. Salient features of algae; Features used for the identification; Classification of algae F E Fritsch.
1.2. Origin and evolution of Algae, Relationships of Algae.
1.3. Thallus organization in algae. Pigments and stored food in algae. flagella types, life cycle and alternation of generations in algae. Evolutionary trends in Algae.
1.4. Brief Account on Indian Algology and major contributors

Module 2. Diversity of Algae (15 hrs)

2.1. Study of the habitat, distribution, habit, anatomy, reproduction and life cycle of Cyanophyceae- *Nostoc* and *Oscillatoria*, Chlorophyceae –*Volvox*, *Zygnema*, *Oedogonium*, *Chara*; Xanthophyceae – *Vaucheria*; Bacillariophyceae - *Pinnularia*; Phaeophyceae – *Sargassum*; Rhodophyceae - *Polysiphonia* (Developmental details are not required). .
2.2. General methods in collection, preservation and Algal culturing. Ecological and economic importance of Algae. Algal blooms.

Module 3. Taxonmy of Bryophytes (8 hrs)

3.1. General characters and classification of bryophytes. Diversity-habitat, thallus structure and Sprophyte structure. Salient features for the identification. Classification.
3.2. Evolutionary trends and affinities with Algae. Evolution of gametophyte and sporophyte among Bryophytes.

Module 4. Diversity of Bryophytes (12 hrs)

4.1. Distribution, morphology, anatomy, reproduction and life cycle of the following types (developmental details are not required): Hepaticopsida - *Riccia*, *Marchantia*; Anthocerotopsida - *Anthoceros*; Bryopsida - *Funaria*.
4.2. General methods in collection and preservation of Bryophytes Ecological and Economic importance of Bryophytes

Module 5. TEACH Space (15 hrs): This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Micropreparations and microscopic observations of vegetative and reproductive structures of model genera of algae and bryophytes.
2. Documentation of algal and bryophyte diversity in various nearby places.
3. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Employability for the Course / Programme
It is one of the intermediate major course which is very essential for understanding the diversity of plants, especially of lower plants, for the completion of BSc Botany.

4	**Angiosperm systematics I**	**KU3DSCPLS202**
Semester: 3 **Hrs/week : 4 Theory + 0 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English
3. Completed the basic foundation courses in the first two semesters

Course Outcomes	
CO1	Knowledge on basic terms and methods in Angiosperms Taxonomy
CO2	Understanding the diversity in angiosperm morphology
CO3	Classification of angiosperms, especially belonging to Polypetalae, based on evaluation of taxonomic characters
CO4	Skill in conducting taxonomic field work, collection and identification of angiosperms.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2						√						
CO3			√		√				√			
CO4							√	√		√		

Course Description
This course is tailored for student majoring in Botany, focusing on foundational aspects of Angiosperm Systematics. The course blends theoretical knowledge and practical skills, including hands-on plant identification, field visits, and herbarium techniques.
• *First module deals with the classification of angiosperms and Indian contribution in taxonomy.* • *Second module draws attention to the vegetative morphology of angiosperms.* • *Third module gives an idea on reproductive morphology of angiosperms.* • *Fourth module is related to the taxonomic characters of selected families in Polypetalae.*
This course will also provide you opportunities to observe diverse angiosperms through the practical sessions on model organisms.

Course Objectives:

1. Develop a Fundamental Understanding of Systematics and Taxonomy
2. Acquire Proficiency in Angiosperm Classification and Nomenclature
3. Explore Polypetalous Plant Families with Economic Significance
4. Integrate theoretical understanding with practical skills through hands-on activities such as plant identification, field visits to botanical gardens or natural

habitats, and herbarium techniques.

5. Prepare Students for Practical Applications in Botany

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4 +0 +0 (60 +0 +0)	4 (60)	30	70	100

COURSE CONTENT

Module 1. Classical Taxonomy of Angiosperms: 10 hrs

1.1 Salient features of Angiosperms; Classification by Linnaeus, Bentham and Hooker .

1.2 Origin and evolution of angiosperms, Relationship, similarities and dissimilarities with Gymnosperms.

1.3. Major Indian contributors:

1.4. Basic Features used for classical systematic of angiosperms. Basic Herbarium technique.

Module 2. Vegetative Morphologic characters: 15 hrs

2.1. Root: types of roots and modifications in angiosperms

2.2. Stem types of stem and modifications in angiosperms

2.3. Leaf types of leaves and phyllotaxy and leaf modifications in angiosperms

Module 3. Reproductive Morphologic characters: 8 hrs

3.1.Flower the sex organ and general features – non essential and essential whoerls. Adhesion and cohesion. Aestivation. Placentation

3.2.Inflorescence- types

3.3.Fruits – types

3.4.Seeds and germination- types

Module 4. Diversity of Polypetalae: 12 hrs

4.1. Study of the distribution, habit, major vegetative and reproductive features Annonaceae, Nympheaceae, Malvaceae, Rutaceae, Anacardiaceae, Fabaceae with sub families.

Module 5. TEACH Space 15 hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Survey and documentation of vegetative modifications in angiosperms.
2. Survey and documentation of reproductive morphology of angiosperms
3. Study of Adhesion, Cohesion, Aestivation and Placentation in common plants.
4. Germination experiments.
5. Major vegetative and reproductive features Annonaceae, Nympheaceae, Malvaceae, Rutaceae, Anacardiaceae, Fabaceae with sub families.
6. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Laboratory reports	5
• Practical Examination	10

Employability for the Course / Programme

It is one of the intermediate major course which is very essential for understanding the diversity of plants, especially of Angiosperms and also for the completion of BSc Botany.

5	**Diversity of Pteridophytes and Gymnosperms**	**KU4DSCPLS203**
Semester: 4 **Hrs/week: 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English
3. Completed the basic foundation courses in the first two semesters

Course Outcomes	
CO1	Acquisition of basic knowledge in the diversity among plants, especially Pteridophytes and gymnosperms.
CO2	Understanding of the life cycles in pteridophytes and gymnosperms.
CO3	Understanding the basic differences that exist among different selected genera of Pteridophytes and gymnosperms.
CO4	Ability to apply the concepts gathered in this course to the field of evolution and ecological studies.
CO5	Firsthand experience in viewing the diversity in tracheophytes using laboratory procedures. .

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√		√						
CO3					√	√	√					
CO4									√	√	√	
CO5									√	√		

Course Description
This is a major intermediate course designed for BSc Botany students. The aim of the course is to give basic knowledge about the diversity of pteridophytes and gymnosperms.
• *First module deals with the taxonomy of Pteridophytes.* • *Second module is giving and idea on diversity of Pteridophytes through selected taxa.* • *Third module is focused on the classification of Gymnosperms.* • *Fourth module is a giving a detailed account on diversity of Gymnosperms.*
This course will also provide you opportunities to observe diverse cells, tissues and organs of Pteridophytes and gymnosperms through the practical sessions on model organisms.

Course Objectives:

1. To expertise in collection, preservation and studies in Pteridophytes and Gymnosperms.
2. To achieve a comparative knowledge of lower vascular plants.
3. To develop skill in proper description, identification and classification through morphological, anatomical and life cycle of ferns and gymnosperms.
4. Consciousness on the origin and evolution of lower groups of plants.

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Taxonomy of Pteridophytes 10 hrs

1.1 Salient features of Pteridophytes; Features used for the identification; Classification of pteridopytes- Reimer

1.2 Origin and evolution of Pteridophytes, Relationships of pteridophytes , similarities and dissimilarities with bryophytes.

1.3. Stelar variation and stelar evolution in Pteridophytes; heterospory and seed habit.

1.4. Brief Account on Indian Pteridology and major contributors

Module 2. Diversity of Pteridophytes 15 hrs

2.1. Study of the habitat, distribution, habit, anatomy, reproduction and life cycle of *Psilotum*, *Selaginella, Equisetum, Pteris* and *Marsilea*. (Developmental details are not required). .

2.2. General methods in collection, preservation, staining techniques for spores and reproductive parts. Ecological and economic importance of Pteridophytes

Module 3. Taxonomy of Gymnosperms 8 hrs

3.1. Salient features of gymnosperms. Classification -Sporne's

3.2. Origin and evolution of Gymnosperms. Relationship with Pteridophytes and Angiosperms

3.3. Distribution of Gymnosperms in India. Gymnosperm studies in India.

Module 4. Diversity of Gymnosperms 12 hrs

4.1. Study of the habitat, distribution, habit, anatomy, reproduction and life cycle of *Cycas, Pinus* and *Gnetum* (Developmental details not required).

4.2. General methods in collection, preservation and staining techniques for the vegetative and reproductive parts of Gymnosperms

4.3. Ecological and Economic importance of Gymnosperms

Module 5. TEACH Space 15 hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Micropreparations and microscopic observations of vegetative and reproductive structures of model genera of Pteridophytes and gymnosperms.
2. Documentation of Pteridophyte and gymnosperm diversity in various nearby places.
3. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Employability for the Course / Programme

It is one of the intermediate major courses which is very essential for understanding the diversity of plants, especially of tracheophytes, for the completion of BSc Botany.

6	Angiosperm Systematics II	KU4DSCPLS204
Semester : 4 **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English
3. Completed the basic foundation courses in the first two semesters

Course Outcomes	
CO1	Acquisition of basic knowledge in the diversity among Angiosperms, other than polypetalae.
CO2	Understanding of modern angiosperm classification.
CO3	Understanding the basic differences that exist among different selected families of angiosperms
CO4	Ability to apply the concepts gathered in this course to the field of evolution and ecological studies.
CO5	Firsthand experience in viewing the diversity of angiosperms using laboratory procedures. .

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2		√	√		√							
CO3				√				√				
CO4						√	√					
CO5									√	√		

Course Description

This course is meant for the student in Botany major, focusing on systematics and taxonomy of selected gamopetalae, monochlamydeae and monocot families. The course blends theoretical knowledge and practical skills, including hands-on training in plant description and identification, field visits, and herbarium techniques.

- *First module deals with modern systematic and typification.*
- *Second module focuses on families belonging to gamopetalae.*
- *Third module outlines the characteristics of selected angiosperm families belonging to monocotyledonae and monochlamydeae.*
- *Fourth module comapares the modern and classical systematics.*

This course will also provide you opportunities to observe diverse angiosperms through the practical sessions on model organisms.

Course Objectives:

1. Develop a fundamental understanding of modern systematics and taxonomy of angiosperms.
2. Acquire Proficiency in Angiosperm Classification and Nomenclature
3. Explore angiosperm families other than Polypetalae with Economic Significance
4. Integrate theoretical understanding with practical skills through hands-on activities such as plant identification, field visits to botanical gardens or natural habitats, and herbarium techniques.
5. Prepare Students for Practical Applications in Botany

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Introduction to Modern systematics of Angiosperms (10 hrs)

1.1 Typification-. Holotype, Syntype, Lectotype, Paratype,
1.2 Rules of Botnaical Nomenclature. ICN. Rule of Priority.
1.3. Numerical Taxonomy, Chemotaxonomy. Molecular Taxonomy.
1.4. Brief account on Phylogentic System of Classification. Engler and Prantle, APG system of classification. Evolution of APG system.

Module 2. Diversity of Polypetalae and Gamopetalae (15 hrs)

Study of the distribution, habit, major vegetative and reproductive features of polypetalae- Combretaceae, Cucurbitaceae and Apiaceae. Study of the distribution, habit, major vegetative and reproductive features of gamopetalae. Rubiaceae, Asteraceae, Sapotaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Acanthaceae, Verbenaceae, Lamiaceae.

Module 3. Diversity of Monochlamydeae and Monocotyledonae (15 hrs)

3.1. Study of the distribution, habit, major vegetative and reproductive features of Monochlamydeae. Euphorbiaceae, Amarantaceae,
3.2. Study of the distribution, habit, major vegetative and reproductive features of Monocotyledoneae. Orchidaceae, Zingiberaceae, Liliaceae, Arecaceae, Poaceae

_*Module 4. Comparative account of modern and classical systematics (12 hrs)*

4.1. Comparative account on classification. Merits and demerits of Bentham and Hookers classification. Bentham and Hooker's Vs. APG system
4.2. Brief account on Phylogenetics and Cladistics in Angiosperms.

Module 5. TEACH Space (15 hrs):
This module is a list of suggested activities that helps to achieve the aim, objectives and

outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Major vegetative and reproductive features of families given above.
2. Visit to a taxonomic research station to gather knowledge on the typification procedures.
3. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Employability for the Course / Programme

It is one of the intermediate major course which is very essential for understanding the diversity of plants, especially of angiosperms, for the completion of BSc Botany/plant science.

7	Genetics	KU4DSCPLS205
Semester : 4 Hrs/week : 3 Theory + 1 Practical		Credits : 4

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English
3. Completed the basic foundation courses in the first two semesters

Course Outcomes	
CO1	Acquisition of basic knowledge in classical genetics
CO2	Understanding the basic mechanism of phenotypic expressions.
CO3	Understanding the basis of differences that exist among different species.
CO4	Ability to apply the concepts gathered in this course to the field of evolution.
CO5	First -hand experience in solving genetic problems

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2					√	√	√					
CO3				√	√							
CO4										√	√	√
CO5							√		√			

Course Description

It is a comprehensive exploration of the fundamental principles and applications of genetics, beginning with an introduction to Mendelian genetics and Molecular Basis of genetics. The course also covers on social relevance of genetics and HGP.

- *First module is an introduction to the branch of genetics.*
- *Second module gives a detailed background and progress of Mendelian genetics.*
- *Third module gives an idea on different types of ratio in phenotypic expression.*
- *Fourth module is focused on the basic knowledge on genes, DNA and chromosomes.*

This course will also provide opportunities to practice the problems in genetics.

Course Objectives:

1. Identify the basic principles and current trends in classical genetics.
2. Recognise the historical process of the evolution of molecular genetics from classical genetics.
3. Review the relevance of the application of genetic principles in agriculture, medicine, research and industry.

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1.Introduction to Genetics (5 hrs)

1.1 Definition and scope of genetics. Brief history of genetics. Early concepts on reproduction and genetics. Phases of genetics.
1.2 Major terms used in genetics - factors, genes, chromosomes, alleles, homozygous and heterozygous, hemizygous, traits, phenotypes, genotypes, locus, linkage, mutation; population, offspring, clone, Test cross, back cross, reciprocal cross.
1.3 Genetics and Epigenetics. Genetics and Society – Euthenics, Eugenics, and Euphenics with examples.
1.4 Human genome project- Mile stones- Major output and their relevance in medicine and disease management.

Module 2. Mendelian Genetics (8 hrs)

a. Brief account of Mendel's life history
b. Mendelian experiments: Monohybrid cross and dihybrid cross, Mendelian ratios, Laws of inheritance.
c. Reasons for Mendel's success. Mendelian Genetics and sexual cycle in plant.
d. Rediscovery of Mendelism. Reasons for negligence of Mendelian discoveries.

Module 3. Mendelian and Non-Mendelian ratios. (17 hrs)

3.1. *Allelic interactions*: dominant – recessive, Incomplete dominance – flower color in Mirabilis; Co-dominance – Coat colour in cattle, Lethal genes – Sickle cell anemia in Human beings.
3.2. Interaction of genes: Non epistatic - Comb pattern inheritance in poultry 9:3:3:1. Epistasis: dominant - Fruit colour in summer squashes12:3:1; recessive - Coat color in mice 9:3:4; Complementary gene interaction- flower color in *Lathyrus* 9:6:1. Inhibitory genes – Leaf Colour in paddy 13:3; Duplicate gene interaction- Shepherd's Purse15:1, Duplicate

genes with cumulative effect-9:6:1.

3.3. Quantitative inheritance- Polygenes-General Characters-. Ear size in corn. Transgressive variation-Heritability Phenotypic expression- Penetrance and expressivity. Pleotropic genes. Examples from plants and human beings.

Module 4. DNA, Genes and Chromosomes (15 hrs)

4.1. Concept of Genes – from factors to the modern concept of gene. Role of chromosomes in inheritance and its significance.

4.2. Chromosome Morphology, Chromosomal nomenclature- Chromatid, Centromere, Telomere, Secondary constriction, Satellite and Nucleolar Organizing Regions.

4.3. Chromosomal classification based on position and number of Centormere. Heterochromatin and Euchromatin, Karyotype and Idiogram.Chromatin reticulum-Structure, Chemical organization of Chromosomes; DNA and Histones. Packaging the DNA into Chromosomes,

4.4. Special types of chromosomes: Polytene chromosomes, Lamp brush chromosomes and B chromosomes.

Module 5. TEACH Space (15 hrs):

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Dihybrid inheritance
2. Allelic and Non allelic Gene interactions.
3. Poster preparation on HGP
4. Poster presentation competition on Chromosome structure.
5. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Employability for the Course / Programme

It is one of the intermediate major course which is very essential for understanding the classical genetics and its relevance; highly essential for the completion of any biological course.

8	Mycology and Plant Pathology		KU5DSCPLS301
DSC	Semester: 5	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Understand fungal biology and classification based on structural, nutritional, and reproductive features of fungi
CO2	Analyze fungal life cycles and their applications in agriculture, industry, and medicine.
CO3	Identify diseases in common crop plants based on the symptoms and causal agents including fungi, bacteria, viruses, phytoplasmas, nematodes, and parasitic plants.
CO4	Evaluate disease dynamics based on disease cycle and epidemiology and Management Strategies including cultural, biological, chemical, and integrated methods.
CO5	Develop skills in diagnosing plant diseases using real-world case studies and recommend appropriate control measures with an understanding of Integrated Disease Management (IDM).

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	✓											
CO2		✓										
CO3			✓			✓						
CO4			✓				✓					
CO5							✓	✓			✓	✓

Course Description

This course provides a basic understanding of fungi and plant diseases. It covers fungal biology, classification, life cycles, and the role of fungi in nature and industry. Students also learn about plant pathogens, disease symptoms, and control methods through theory and practical sessions.

- First module gives a general idea on fungal classification.
- Second module gives details on life cycles and the ecological and economic roles of key fungi.
- Third module gives a general account on plant disease causes, types, spread, and basic control methods.
- Fourth module is a detailed account on present's case studies of major plant diseases and their management.

This course equips students with foundational knowledge in mycology and plant pathology, helping them understand fungal diversity, plant diseases, and effective management strategies through both theoretical insights and practical experience.

Course Objectives:

1. Understand the fungal diversity through the differences in basic structure and reproduction of fungi along with their classification.
2. Learn about important fungi and their role in the environment and economy.
3. Study plant diseases, their causes, symptoms, and how they spread.
4. Develop skills to diagnose plant diseases and apply control methods.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	25	50	75

COURSE CONTENT

Module 1: General Mycology 10 Hours

1.1. General Characteristics of Fungi Eukaryotic nature, heterotrophic nutrition, Cell wall composition, food storage, Thallus organization and structure. Asexual and sexual reproductive mechanisms. Similarities between some fungal groups with other groups- bacteria and algae.

1.2. Classification of Fungi -Overview based on Alexopoulos et.al. (1972). Recent advances in Fungal classification. Key features and examples of: *Zygomycetes, Ascomycetes, Basidiomycetes, Oomycetes, Mitosporic fungi*

1.3. Symbiotic Associations with algae:, Lichens- General characters of lichens. Classification of Lichens- Crustose, Foliose and Fruticose. Structure, Reproduction and Life cycle of Usnea. Economic importance and Ecological significance of Lichens

1.4. Symbiotic Associations with other plants- Mycorrhiza- General features- Endomycorrhiza and ectomycorrhiza. VAM fungi.

Module 2: Life Cycles and Significance of Fungi: 10 Hours

2.1.Morphology and Reproduction of Selected Genera: *Rhizopus, Pythium, Saccharomyces*

2.2.Detailed Life Cycles: *Penicillium, Peziza, Puccinia, Cercospora*

2.3. Ecological Role of Fungi: Fungal involvement in decomposition of organic matter and nutrient cycling. Applications in Agriculture- Cultivation of Edible mushrooms

2.4. Industrial uses of Fungi: *Fermentation, antibiotic production*

2.4. Human life and Fungi: Major fungal diseases of man. Allergy of fungal spores. Food spoilage. Fungal toxins

Module 3: Fundamentals of Phytopathology 8 Hours

3.1. Concepts and Causes of Disease: Definition of plant diseases. Common causative agents and symptoms.

3.2. Classification and Transmission: Classification based on symptoms and causative agents- *Fungi, bacteria, viruses, nematodes, phytoplasmas*. Disease dissemination and transmission pathways.

3.3. Disease Cycle and Epidemiology: Simple vs. compound interest diseases. Host-pathogen interactions and disease triangle

3.4.Plant Disease Management: Approaches: Legal- certified seeds and plant quarantine, cultural practices- importance of felling of diseased plants, distance between plants, intercropping, mixed cultivation Vs Monocultures, Greenhouses and Precision farming. Biological and chemical measures (fungicides, bactericides). Breeding for disease resistance.

Module 4. Case Studies in Plant Pathology 8 hours

4.1. Fungal and Bacterial Diseases: Symptoms and control measures of Citrus canker (Xanthomonas citri), Mahali of arecanut (Phytophthora arecae), Grey leaf spot of coconut (Pestalotia palmarum) and Abnormal leaf fall of rubber (Phytophthora palmivora)

4.2. Viral and Phytoplasma Diseases: Symptoms and control measures of Banana bunchy top (Virus) and Coconut root wilt (Phytoplasma)

4.3. Nematode Diseases: Symptoms and control measures of Root knot in Banana (Meloidogyne incognita).

4.4. Role of Integrated Disease Management (IDM)

Module 5. TEACH SPACE 9 Hrs
This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. Theory 9Hrs General microbiology and Bacteriology: plant microbe interactions. Significance of microbiology. Practical 30 Hrs 1. Microscopy and Slide Observation: *Rhizopus*, *Penicillium*, *Puccinia* (uredia, telia), *Cercospora*. Budding in *Saccharomyces*, ascocarps in *Peziza*. 2. Plant Disease Specimens: Study of symptoms: Citrus canker, Bunchy top of banana. Abnormal leaf fall of rubber 3. Gross and micromorphology of Trichoderma 4. Application of Pseudomonas fluorescence by seed biopriming and soil treatment 5. Observation of AM fungi in roots by staining with writing ink. 6. Disease Diagnosis and Management: a. Preparation of disease cycle charts. b. Demonstration of Bordeaux mixture preparation. c. Field Visit to study of diseases in local farms/plantations. 7. Practical Records and Viva

Suggested Assignment Topics- Theory

1. Diseases of crops and their control measures
2. Fungal disease of man and its treatment
3. Nutrition of Fungi
4. Relationship between termites and fungi
5. Tissue culture for disease resistance
6. Breeding for disease resistance

Suggested Assignment Topics- Practical

1. Collection and preservation of fungi
2. Observation of diseased crop plants and fungi using mobile camera/ digital camera and prepare a report
3. Common Seedling stage diseases
4. Common plant diseases during reproductive stages

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Agrios, G.N. (2005). *Plant Pathology*, 5th Ed. Academic Press.
2	Alexopoulos, C.J., Mims, C.W., & Blackwell, M. (1972). *Introductory Mycology*. Wiley.
3	Bilgrami, K.S., Dube, H.C. (1990). *Modern Plant Pathology*. Vikas Publishing.
4	Mandahar, C.L. (2007). *Introduction to Plant Viruses*. Springer.
5	Mehrotra, R.S. & Aneja, K.R. (2003). *An Introduction to Mycology*. New Age International.
6	Rangaswami, G. & Mahadevan, A. (2001). *Diseases of Crop Plants in India*. PHI.
7	Sanjeev Kumar 2021. Fundamentals of Plant Pathology. ISBN: 9789390591206. New India Publishing Agency.
8	Tripathi S K, Bhale M S, Yadav V K and A Srivastava, 2024. *Fundamentals of Plant Pathology*. Asha Book House.
9	https://bio.libretexts.org/

10	https://www.apsnet.org/edcenter/Pages/IntroOomycetes.aspx?utm_source
11	https://plantlet.org/an-overview-of-oomycetes/?utm_source

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• Theory Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Presentations and Viva Voce	5
• Practical Records, Reports and submissions by students	5
• Internal Practical Examination	10

Employability for the Course / Programme

This course provides an engaging and comprehensive introduction to the study of fungi and plant diseases. Through hands-on learning and scientific observation, students will develop analytical and diagnostic skills essential for careers in mycology, plant pathology, agriculture, biotechnology, and environmental sciences.

09	Phytochemistry		KU5DSCPLS302
DSC	Semester: 5	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Ability to identify and classify major biomolecules and their plant functions
CO2	Understands structural and functional aspects of proteins and lipids
CO3	Correlates biomolecular structure to their biological roles
CO4	Understands energy flow in biological systems
CO5	Analyze enzyme function, classification, and regulation
CO6	Apply principles of enzyme kinetics to biological reactions

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4				√	√			√	√	√	√	
CO5									√	√	√	
CO6										√	√	√

Course Description

This is a course designed to provide a foundational understanding of structure and functional role of various biochemical compounds and thereby understanding the phytochemical basis of plant structure, function, and secondary metabolite production, including recent developments in plant biochemistry.

- *First module is dealing with bioenergetics, enzyme kinetics and buffer chemistry that helps to make an interest in biochemistry.*
- *Second module is helping the student to get more vision on the basic chemicals of organisms- carbohydrates, proteins and lipids.*
- *Third module is a voyage to the knowledge field of phytohormones, secondary metabolites and phytotoxins.*
- *Fourth module delves into the field of modern applications of phytochemistry*

This course will provide opportunities to get a firsthand experience in qualitative and quantitative assessment of phytochemicals.

Course Objectives:

1. To gather the basic knowledge in phytochemistry that helps to make a conceptual basis on plant metabolism.
2. To apply phytochemical knowledge to plant-based health applications.
3. To understand the link between plant metabolism and environmental adaptation and evolution.
4. To appreciate the value of traditional knowledge in modern science.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	25	50	75

COURSE CONTENT

Module 1: Concepts in bioenergetics, buffers and enzymology 15 Hours

1.1. Bioenergetics: Laws of Thermodynamics in biological systems. Gibbs free energy, endergonic and exergonic reactions. High-energy compounds: ATP, NADPH, $FADH_2$, FMN – structure and function. Emphasis on ATP as the universal energy currency

1.2. Acid and Bases, ionisation of water, dissociation of acids, Henderson- Hasselbalch equation, pKa. Buffers - Common buffers (acetate, citrate and phosphate), buffer action, buffer capacity

1.3. Principles of Enzymology – Enzyme classification (IUBMB system). Enzyme kinetics, Michaelis-Menten constant-, Km and Vmax. Lineweaver-Burk plot. Mechanism of enzyme action: Lock-and-key, Induced-fit models. Factors affecting enzyme activity: Temperature, pH, substrate concentration. Types of enzyme inhibition: Competitive, non-competitive, uncompetitive. Allosteric regulation and feedback inhibition. substrate specificity and regulation of enzyme activity.

1.4. Structure and classification of Enzymes: Active sites and inhibitors, Apoenzymes and holoenzymes. Coenzymes and cofactors. Endo- and exoenzymes, constitutive and inducible enzymes**.** Multienzyme, isoenzymes, zymogens, ribozyme, abzyme. Detailed study of structure and function of FAS and Rubisco.

Module 2: Carbohydrates. Lipids and Proteins 20 Hours

2.1. Basics of biochemistry: History, Significance of Biochemistry and Biomolecules. Indian contributors- - Ramachandran, Bhargava.

2.2. Carbohydrates: General structure – linear and ring structures. Major bonds in carbohydrates and their properties. Classification of carbohydrates- Monosaccharides (triose, pentose, hexose). Examples: Glyceraldehyde, ribose, deoxyribose, glucose, fructose. Disaccharides: Maltose, lactose, sucrose. Polysaccharides: Starch, cellulose, glycogen. Biological roles of carbohydrates in plants.

2.3. Lipids: Classification: Simple (fats, oils), complex (phospholipids, glycolipids). Storage and structural lipids. Membrane lipids: phospholipids, sterols. Functions in energy storage, signaling, membrane structure

2.4. Proteins and Amino Acids: Classification of amino acids (based on polarity, charge). Proteinogenic vs non-proteinogenic amino acids. Protein structure: Primary, secondary, tertiary, quaternary. Protein folding, denaturation and renaturation. Classification based on function (enzymes, storage, structural, transport).

Module 3: Phytohormones, Secondary metabolites and phytotoxins 15 Hrs

3.1. Phytohormones: Structure and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene.

3.2. Secondary Metabolites in Plants: Definition and importance of secondary metabolites. Structure, properties and classification of Alkaloids, phenolics, flavonoids, terpenoids, tannins, saponins, glycosides. Role in plant defense, pigmentation, allelopathy, symbiosis. Ecological and evolutionary significance

3.3. Phytochemical Analysis Techniques: Extraction methods: Solvent extraction,

distillation, Soxhlet, maceration. Preliminary phytochemical screening tests. Chromatography techniques: column chromatography. Spectrophotometry in compound identification 3.4. Poisons from plants: Alkaloids (e.g., atropine), Glycosides (e.g., cyanogenic glycosides), Proteins and peptides (e.g., ricin), Oxalates, resins, saponins. Major poisonous plants and their toxins: *Ricinus communis, Nerium oleander, Abrus precatorius, Datura stramonium and Thevetia peruviana*.
Module 4. Applied Plant Biochemistry 10 hrs 4.1. Ethnobotany and Traditional Knowledge Systems. Role of traditional medicine and plant-based remedies. Integration of ethnopharmacology with modern phytochemistry 4.2. Plant Biochemistry and Human Health. Examples and roles for the following applications: Nutraceuticals and functional foods. Antioxidant compounds in plants (flavonoids, polyphenols). Phytochemicals in anti-inflammatory, anti-cancer, and antimicrobial activity. 4.3. Plant-Environment Interactions: Role of phytochemicals in abiotic stress tolerance (UV, salinity, drought). Allelopathy and plant defense compounds. 4.4. Recent Advances in Phytochemistry: Role of metabolomics in plant biochemistry. Bioprospecting of medicinal plants for drug discovery. CRISPR and metabolic engineering of secondary metabolite pathways. Synthetic biology approaches to plant natural product production.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5Hrs** Application of various phytochemicals in daily life. Medicines from plants. Dyes from plants. Tannin and resin yielding plants of our locality. Natural fibres from plants and their physico- chemical properties and significance. **Practical 10 Hrs** 1. Qualitative tests for carbohydrates (reducing sugars, non reducing sugars and polysaccharides), proteins and lipids 2. Qualitative tests for secondary metabolites -alkaloids, tannins, saponins, phenolics 3. Spectrophotometry for the quantitative assessment of carbohydrates (reducing sugars, non reducing sugars and polysaccharides), proteins and lipids.

Suggested Assignment Topics- Theory

1. Treatment of plant resources for various purposes- paper making, plywood making,
2. Temperature treatment of woods and canes for furniture making
3. Various phytochemical analysis methods relevant to industrial and research exposure.

Suggested Assignment Topics- Practical

1. Industrial visit to the industry- plywood factory, paper factory
2. Study visits to physiology and biochemistry labs of universities and research institutes to get exposure in the field of phytochemistry.

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Attri L K and V C Chandel, Fundamentals of Plant Biochemistry, New Delhi Publishers. ISBN NO:9789393878137.
2	Beck, CB. (2005). An introduction to plant structure and development. Cambridge University Press.
3	Berg, J.M., Tymoczko, J.L. & Stryer, L. (2006). Biochemistry (6th ed.). W. H. Freeman & Co.

4	Bewley, J.D. & Black, M. (1994). Seeds: Physiology of development and germination (2nd ed.). Plenum Publishing Corporation.
5	Bharadwaj R and P Chowdhury, 2023. Plant Secondary Metabolites. Agrobios.
6	Bidwell, R.G.S. (1979). Plant physiology (2nd ed.). Macmillan Publishing Corporation.
7	Boopathi C A, 2021. Medicinal and Poisonous plants of India. MJP Publisher. ISBN-10: 8180942856; ISBN-13: 978-8180942853.
8	Buchanan, B.B., Gruissem, W. & Jones, R.L. (2000). Biochemistry and molecular biology of plants. American Society of Plant Biologists.
9	Caius, J F, 1986. Medicinal and Poisonous Plants of India. White Lotus books, Jodhpur.
10	Daniel, M. (1989). Basic biophysics for biologists. Agro-Botanica Publishers and Distributors.
11	Davies, P. J. (2004). Plant hormones: Biosynthesis, signal transduction, action (3rd ed.). Kluwer Academic Publishers.
12	https://bsi.gov.in/uploads/documents/Public_Information/publication/books/miscellaneous/Selected%20Poisonous%20Plants%20from%20the%20Tribal%20Areas%20of%20India.pdf
13	https://www.cambridge.org/core/books/abs/plant-physiology/secondary-plant-metabolites/B108DB3F91D16CA2C546287B852FD033
14	Nagaraj G, 2022. Principles of Plant Biochemistry, Narendra Publishing House. ISBN: 9789390611805
15	Sharma A. K., Sharma A., (2022). Plant secondary metabolites. Singapore: Springer.
16	Taiz, L. & Zeiger, E. (2002). Plant physiology. The Benjamin Cummings Publishing Corporation.
17	Twaij B M and Hasan M N, 2022. Bioactive Secondary Metabolites from Plant Sources: Types, Synthesis, and Their Therapeutic Uses; *Int. J. Plant Biol.* 2022, *13*(1), 4-14; https://doi.org/10.3390/ijpb13010003 (https://www.mdpi.com/2037-0164/13/1/3)
18	Upadhay, A., Upadhay, K. & Nath, N. (2008). Biophysical chemistry: Principles and techniques. Himalaya Publishing House.
19	Voet, D.J. & Voet, J.J. (2005). Biochemistry (5th ed.). John Wiley & Sons.
20	Wilkins, M.B. (1984). Advances in plant physiology. Longman Scientific & Technical.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Industrial and institute visit	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• Theory Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5

•	Presentations/ demonstrations/Viva Voce	5
•	Practical records, reports and submission by the students	5
•	Internal Practical Examination	10

Employability for the Course / Programme

The experiential learning results in a lineage towards the utilisation of ethnobotanical knowledge for the innovative efforts of industry and research.

10	Basics in Molecular biology and Genetics		KU5DSCPLS303
DSC	Semester: 5	Hrs/week: 4 Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level

2. Ability to write examination in English

Course Outcomes	
CO1	Explain the molecular basis of genetic information by understanding the structure and function of DNA.
CO2	Describe the processes of gene expression and regulation in a stepwise manner starting from transcription to protein folding.
CO3	Analyze genetic variation and inheritance patterns
CO4	Understand chromosomal and molecular mechanisms underlying sex determination and genetic disorders
CO5	Evaluate the impact of mutations and DNA repair mechanisms on genome stability

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This biology course designed to provide a foundational understanding of molecular biology and classical & human genetics, with a focus on how molecular events influence phenotypic traits and genetic disorders.
• *First module is dealing with the basics of molecular biology structure of DNA and RNA, DNA replication in prokaryotes and eukaryotes.* • *Second module delves into the molecular mechanisms in the central dogma, from transcription to protein folding.* • *Third module is enlisting the molecular basis of mutation and basis of sex determination in plants and organisms including man.* • *Fourth module focusses on the human genetics to get a comprehensive idea on human traits, diseases and syndromes and cancer.*
This course will provide an opportunity to get a strong conceptual foundation on the interrelationship of molecular biology, biochemistry and genetics.

Course Objectives:

1. Demonstrate an understanding of the molecular structure of DNA and explain the experimental evidence supporting its role as the genetic material.
2. Describe the mechanisms of gene expression and regulation, including transcription, translation, and the functional roles of different RNA types in prokaryotic and eukaryotic systems.
3. Apply Mendelian and non-Mendelian principles to analyze patterns of inheritance, including sex-linked traits, extranuclear inheritance, and gene mapping through linkage and recombination.

4. Explain the genetic and chromosomal mechanisms of sex determination and identify the genetic basis of common human syndromes and disorders, including those related to cancer.
5. Analyze the causes and consequences of mutations and describe cellular mechanisms for DNA repair and their role in maintaining genome stability.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (45+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Introduction to Molecular Biology 8 hrs

1.1. History of Molecular Biology. Evidences DNA as genetic material: Griffith, Avery–McLeod–McCarty experiments.
1.2. DNA and Genes: Watson-Crick model of DNA. Chargaff's rules and DNA forms: A, B, C, D and Z. Concept of gene: Cistron, recon, muton.
1.3. DNA replication: Mechanism, enzymes, types (semi-conservative, rolling circle). Comparison between Prokaryote and Eukaryote DNA replication.
1.4. One gene-one enzyme/polypeptide hypotheses. Introns, exons, and mobile genetic elements (transposons). Genetic code: Features, codon–anticodon relationship.

Module 2: Gene Expression and Central Dogma 15 hrs

2.1. Transcription: Mechanism (initiation, elongation, termination) Post-transcriptional modification: Capping, polyadenylation, splicing.
2.2. RNA types: Structure and function of mRNA, tRNA, rRNA
2.3. Translation: Protein synthesis mechanisms (initiation to termination) Post-translational modifications (brief)
2.4. Regulation of central dogma in Prokaryotes - Operon concept – lac and trp operons. Regulation in Eukaryotes Chromatin- states (active/inactive), promoter function.

Module 3: Molecular basis of mutation and Sex determination 15 hrs

3.1. Mutation. Definition and History. Types of mutagens: Chemical and physical. Significance of mutation in evolution
3.2. Types of Mutations and Mechanisms: Transition, transversion, frameshift mutations. Molecular basis: Tautomeric shift, alkylating agents, base analogues. DNA repair mechanisms- brief overview.
3.3. Concept of Genes – from factors to the modern concept of gene. Role of chromosomes in inheritance and its significance. Extra-chromosomal inheritance: Four o'clock plant (variegation), Poky in Neurospora.
3.4. Sex Determination and Genetics- Theories of sex determination: Chromosome theory (Grasshopper, Man, Drosophila). Genic balance theory, Dosage compensation, Lyon hypothesis. Sex determination in plants (Melandrium, Dioscorea, Sphaerocarpus). Sex-linked inheritance: X-linked (e.g., eye color in Drosophila), Y-linked inheritance. Sex-limited and sex-influenced traits.

Module 4. Human Genetics and Genomic Applications 10 hrs

4.1.Human Genetics and Traits: Mendelian inheritance in humans, Blood groups (ABO and Rh), Quantitative traits: Skin color, IQ.
4.2.Genetic disorders: Hemophilia, chromosomal syndromes- Down, Turner, Klinefelter, Cri-du-chat.

4.3. Genetics of Cancer. Features of cancer cells. Genetic basis of carcinogenesis-oncogenes and Tumour suppressor genes. Oncogenes vs tumor suppressor genes. 4.4.Human Genome Project: Scope, objectives, impact
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. Theory 5Hrs **Chromosome Mapping** (5 hrs) • Linkage: Complete (Drosophila) vs Incomplete (Maize) • Independent assortment vs linkage • Mechanism of crossing over, cytological evidence • Gene mapping: Two-point and three-point test crosses • Interference and coincidence Practical 7 Hrs 1. Mapping of genes- two point and three point test cross 2. Pedigree analysis of human diseases 3. Knowing the basic Human Genome through websites 4. Molecular biology problems – mutation and cancer

Suggested Assignment Topics- Theory

1. Molecular basis in diagnosis for cancer and syndromes
2. Molecular level treatments
3. Membrane molecular biology and diseases
4. Genetic basis of gender and impact of epigenetics

Suggested Assignment Topics- Practical

1. Display of Videos on cancer, HGP, Plant genome projects
2. Visit to molecular biology institutions to know the tools and techniques in the area.
3. Practicing referring scientific journals and magazines

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Acquaah, G. (2007). Principles of Plant Genetics and Breeding. Blackwell Publishing Ltd. USA.
2	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2010). Essential Cell Biology. Garland Science.
3	Allison, L. (2007). Fundamental Molecular Biology. Blackwell Publishing Co. Carroll, S.B. (2004). From DNA to Diversity. Blackwell Publishing Co.
4	De Robertis, E.D.P. & De Robertis, E.M.F. (1987). Cell and Molecular Biology. Lea & Febiger.
5	Glick, B.R. & Thompson, J.E. (1993). Methods in Plant Molecular Biology and Biotechnology. Promega. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. & Veres, R.C. (2006). Genetics – From Genes to Genomes (3rd ed.). McGraw Hill.
6	https://assets.vmou.ac.in/MBO08.pdf
7	https://dpbck.ac.in/wp-content/uploads/2022/09/Cell-Biology-Verma-and-Agarwal.pdf
8	https://wisdompress.co.in/wp-content/uploads/2023/10/A-Textbook-of-Human-Genetics.pdf
9	https://www.researchgate.net/publication/373921396_7_Molecular_Biology_and_Human_Genetics_An_Overview
10	Janet, L. & Wallaca, M. (2017). Karp's Cell and Molecular Biology. John Wiley and Sons Inc. Karp, G. (2004). Cell and Molecular Biology: Concepts and Experiments (4th ed.). Wiley.
11	Krebs, J.E., Goldstein, E.S., & Kilpatrick, S.T. (2018). Lewin's Genes XII. Jones and Bartlett Learning. Lewin, B. (2008). Genes IX. Jones and Bartlett Publishers.

12	Lodish, H., Berk, A., Kaiser, C.A. & Kreiger, M. (2012). Molecular Cell Biology (7th ed.). W.H. Freeman.
13	Morris, K.V. (2008). RNA and the Regulation of Gene Expression: A Hidden Layer of Complexity. Caister Academic Press.
14	Pon, L.A. & Schon, E.A. (2001). Mitochondria. Academic Press. Scicchitano, D. (1998). Molecular Cell Biology. W. H. Freeman & Co.
15	Turner, B.M. (2002). Chromatin and Gene Regulation. Blackwell Publishing Co. Weaver, R.F. (2008). Molecular Biology. McGraw Hill.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Journals and websites ➢ Bioinformatic databases	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

This course induces the student to gather more knowledge and skill in the field of molecular biology, genetics and consequently moves to the field of biological research.

11	Bio-instrumentation and Computers		KU5DSEPLS304
DSE	Semester: 5	Hrs/week: 4 Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Define and explain the role of bioinstrumentation in life science research.
0CO2	Understand core principles like accuracy, sensitivity, and signal detection.
CO3	Explain the optical and chemical principles that underpin commonly used lab instruments
CO4	Use computers for data acquisition, monitoring, and control, and implement software solutions.
CO5	Recognize the importance of calibration, data integrity, and lab safety in using bio instruments

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√				√							
CO2		√	√		√							
CO3	√						√					
CO4		√	√					√	√			
CO5	√								√		√	

Course Description
This is an introductory biology course designed for UG students in general and BSc Botany and Plant Science in particular. This course introduces the principles and applications of instrumentation systems and their integration with computer technologies.
• *First module is dealing with the fundamental principles of bioinstrumentation and laboratory safety protocols.* • *Second module provides an outline on basic optical instruments -microscopes, colorimeter and spectrophotometer used in biology and biochemistry.* • *Basics on chemistry of buffers, principle and working of pH meter and separation techniques useful in biology are focussed in third module of this course.* • *Fourth module is an introduction to the world of computers.*
This course will provide opportunities to visit well equipped labs in biology and will get first hand experience in the laboratory with the available equipment.

Course Objectives:

1. Understand the basic operating principles of commonly used scientific laboratory instruments such as autoclaves, spectrophotometers, centrifuges, microscopes, and incubators etc.
2. Develop skills in the safe handling, maintenance, and calibration of laboratory equipment.
3. Recognize the importance of accurate measurement and data collection in scientific experiments.
4. Gain foundational knowledge of computers, including hardware components, operating systems, and basic software applications used in laboratories.
5. Understand how laboratory instruments interface with computers for tasks such as data logging, automated control, and result interpretation.

Credit	Teaching Hours	Assessment

L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Fundamentals of Bioinstrumentation and laboratory safety 12 Hrs

1.1 Bioinstrumentation: Definition, scope, and relevance in biology and research. Introduction to Instrument Maintenance**-** Handling and care of glassware and electronics, Storage practices, cleaning protocols, avoiding contamination.

1.2. Measurement Principles: Accuracy, precision, sensitivity, specificity and resolution. Calibration and Standardization: Importance of calibration, standard operating procedures, reference standards. Biological relevance of physical quantities, Common units in bioinstrumentation.

1.3. Electronic, Electromagnetic and Electrical Principles: Signal Detection and Processing: Biological signals, signal amplification, noise reduction. Transducers and Their Applications: Types of transducers, biological to electrical signal conversion. Optical Principles in Instruments: Light absorption, reflection, refraction, Beer-Lambert law

1.4. Laboratory Safety and Biosafety**-** General lab safety – chemical, electrical, biological. UNESCO guidelines on lab safety practices. Biosafety levels (BSL I–IV), personal protective equipment (PPE), waste disposal.

Module 2: Optical instruments 12hrs

2.1. General classification of microscopes, Parts and working principle of a compound microscope. Magnification, resolution, and contrast. Lens types: Objective and ocular – basic functions. Phase contrast Microscopy.

2.2. Electron microscopy. Parts, Principles and steps in TEM and SEM. Comparative account of image quality and applications of LM with TEM and SEM.

2. 3. Comparative account of sample processing for LM, TEM and SEM. Sample Preparation Techniques- Hand sectioning and microtome sectioning. Embedding. Staining techniques – common stains (safranin, iodine, acetocarmine, Osmium tetroxide). Mounting – media and methods.

2.4. Analytical Instruments- Colorimeter – parts, working principle, biological applications. Spectrophotometer – types, working and uses. Comparison of spectrophotometer and Colorimeter.

Module 3: pH meter and Separation techniques 12 Hrs

3.1. pH and Buffers**-** pH: definition, importance in biological systems, Working of a pH meter, calibration. Buffers used in pH meter. Role of buffers in living organisms and biological research.

3.2. Centrifugation – principle, types (simple table top, differential, high speed and refrigerated), protocol for the separation of chemicals- DNA and proteins, and cell organelles.

3.3.Chromatography– principle, types and applications of paper chromatography, thin-layer chromatography (TLC) and HPLC.

3.4. Electrophoresis– principle, types and applications of Agarose gel electrophoresis, principles

Module 4. Computer as a tool for biological study 12 hrs

4.1. Fundamentals of Computer: Characteristics. Generations of Computers. Parts of a personal computer – Hardwares: main components- CPU, ROM, RAM, HDD/SSD, input/output devices. Soft wares: Overview of Operating Systems- DOS, Microsoft, Linux. Graphical User Interface GUI.

4.2. Networking and Wireless Technology- Networking and Wireless Technology, Local area networks N), wide area networks (WAN). Internet Access Methods – Dial up, Cable TV, Satellite, Wi-Fi,

Bluetooth, mobile data in data sharing and collaboration. 4.3. Application software: Word processors, spreadsheets (Excel), presentation tools (PowerPoint). Tools for biology: Graphing tools, statistical packages (SPSS, R programming), data analysis platforms. 4.4. Digital Literacy in Research- Use of internet in literature review and data collection. Online databases: NCBI, PubMed, Science Direct**.** Biodiversity databases. Referencing and plagiarism checking tools. AI tools relevant to botanical research.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5Hrs** Microtechnique, microscopic phot and video documentation, Any programmes softwares useful for students. Basics of computer in Biostatistics, graphs and Charts and statistical tools. **Practical 7 Hrs** 1. Demonstration of Paper Chromatography/TLC 2. Spectrophotmetric analysis/ Colorimetric analysis 3. Use of pH meter and colorimeter 4. Microscope handling and slide preparation. 5. Diagrams and photographs of instruments for identification 6. Preparation of presentations and graphs using computer 7. Diagrams and photographs of I/O devices for identification

Suggested Assignment Topics- Theory

1. Types of Light microscopy techniques- bright field/ darkfield/ fluorescence
2. Various centrifugation protocols for isolation of cell organelles and inclusions
3. Microtechniques using microtome
4. Staining techniques in microscopy

Suggested Assignment Topics- Practical

1. Microscopic staining techniques
2. Microtechnique
3. PH Meter and water analysis
4. Qualitative and quantitative analysis using Spectrophotometer
5. Demonstration of electrophoresis
6. Various centrifucation techniques

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Alan Evans, Kendal Martin et al., Technology in Action, Pearson Prentice Hall (3rd edn.).
2	Alexis Leon & Mathews Leon, Computers Today, Leon Vikas.
3	Bajpai, P.K. (2008). Biological instrumentation and methodology, S. Chand and company Ltd, .New Delhi.
4	Casey E. J. - Biophysics – Concepts and Mechanics Van Nostrand Reinhold Company.
5	Galen .W. Ewing - Instrumental methods of chemical analysis Mc - Graw Hill Book Company.
6	Ghosal S and A S Avasthi, 2023. Fundamentals of Bioanalytical Techniques and Instrumentation. Prentice Hall India Learning Pvt Ltd.
7	Graeme P. Berlyn and Jerome P. Miksche, 1976. Botanical Microtechnique and Cytochemistry.
8	Peter Norton, Introduction to Computers, 6th edn., (Indian Adapted Edition).
9	Satish Chandra and Gyanendra Kumar, 2023. Bio-Instrumentation and Biological Techniques, PK Publishers and Distributors.
10	Seidman L A, M E Kraus and D L Brandner, 2022. Laboratory Manual for Biotechnology

	and Laboratory Science, ISBN 13 9781032419916, Taylor and Francis Ltd.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Lab visit ➢ Demonstrations	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

Graduates will be equipped with the theoretical and practical knowledge in bioinstrumentation that will help to attain research competence needed to get job in academia, industry, and government sectors.

12	Plantation Management		KU65DSEPLS305
DSE	Semester: 5	Hrs/week: 4 Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Apply basic principles of farm management and select appropriate machinery for plantation operations.
CO2	Demonstrate understanding of HR practices, leadership, and labour relations in plantation settings.
CO3	Analyze economic aspects and growth factors of plantation crops in Kerala and India.
CO4	Identify and interpret key legal provisions relevant to plantation labour and management.
CO5	Perform practical tasks through field visits and activities related to farm and workforce management.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√		√	√				
CO3						√						
CO4									√	√	√	
CO5									√			

Course Description

This course introduces the fundamental concepts of farm management, human resource practices, plantation economics, and legal frameworks relevant to the plantation sector. It also includes practical sessions aimed at experiential learning.

- *The first module focuses on the principles of farm planning and budgeting, with an emphasis on machinery used in plantation crop management.*
- *The second module explores human resource management, covering recruitment, training, leadership, communication, and labour relations in plantation settings.*
- *The third module deals with the economic significance of plantation crops, highlighting productivity issues, market dynamics, and the plantation sector's role in Kerala’s economy.*
- *The fourth module explains key labour laws governing plantation work, emphasizing worker welfare, safety, wages, and benefits.*

This course helps learners understand the integrated approach required in managing plantations efficiently, blending agricultural practices with human, economic, and legal considerations and also provides hands-on learning through field visits, equipment demonstrations, leadership activities, and documentation exercises.

Course Objectives:

1. To understand the principles of farm management, planning, budgeting, and use of machinery in plantation crops.
2. To learn the basics of human resource management, including recruitment, training, leadership, and labour relations in plantations.
3. To explore the economic importance of plantation crops and factors influencing their productivity and sustainability.
4. To gain knowledge of legal provisions and labour laws relevant to the plantation sector.
5. To develop practical skills through field visits and activities related to plantation management and workforce engagement.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Farm Management and Machinery 12 Hours

1.1. Introduction to Farm Management: Definition, scope, and importance. Principles of farm management: Efficiency, profitability, sustainability. Functions: Planning, organizing, directing, controlling.

1.2. Plantation Crop Planning: Cultivation planning and budgeting for major Kerala plantation crops: Tea, Coffee, Rubber, Cocnut, Arecanut, Black Pepper. Use of enterprise budgeting and partial budgeting. Crop calendars and intercropping strategies.

1.3. Farm Machinery and Equipment: Weed cutters: Manual, motorized types. Sprayers: Rocker, knapsack, power sprayers – use and safety. Dusters: Lime sulfur, sulphur-based dusting. Processing equipment: Rubber rollers and smoking units. Coconut and arecanut dehuskers.

1.4. Sustainable Farm Management Practices: Use of digital tools: GPS, mobile apps, plantation management software (like FarmERP). Water conservation, soil health management. Agroforestry and organic farming practices in Kerala. Environmental and economic sustainability

Module 2: Human Resource Management (12 Hours)

2.1. Introduction to HRM: Definition, objectives, and importance. Difference between personnel management and HRM. Challenges in plantation sector HRM

2.2. HR Planning and Development: Recruitment and placement in plantations. Training methods for seasonal vs permanent staff. Performance appraisal systems. Promotion and career development

2.3. Leadership and Communication: Leadership styles in rural/plantation settings (autocratic, democratic, etc.). Types of communication: vertical, horizontal, informal. Motivation and workforce morale in plantations.

2.4. Labour Relations and Conflict Management. Trade unions in Kerala plantations. Case studies – (layoff, retrenchment, and grievances) and their handling. Gender and caste issues in plantation labour.

Module 3: Economics of Plantation Crops (12 Hours)

3.1. Agriculture and the Economy: Role in Indian GDP, employment, rural livelihoods
Linkages between agriculture and industry.

3.2. Plantation Crops in Indian Economy: National economic contribution of Tea, Coffee, Rubber, Cashew. Post-liberalization impacts (1991 onwards). Export trends and global market dynamics.

3.3. Factors Affecting Plantation Growth. Productivity issues: aging plantations, pest/disease, climate. Labour shortage and mechanization. Landholding fragmentation in Kerala. Input cost rise and market price volatility.

3.4. Plantation Sector in Kerala: Plantation statistics: area, productivity, employment. Social impact: tribal communities, women in plantations. Environmental impact: monocultures, deforestation. Role of Plantation Corporation of Kerala, Government Schemes, and Spice

Board.
Module 4. Legal Aspects of Plantation Management (12 Hours) 4.1. Plantation Labour Act, 1951: Definitions, scope. Welfare provisions: crèches, housing, medical. Working conditions, leave, overtime. Penalties, inspections, enforcement in Kerala 4.2. Minimum Wages Act, 1948: Wage structures in the plantation sector. Kerala-specific wage boards and notifications. Implementation and challenges. 4.3. Employees' State Insurance Act, 1948: ESI applicability in plantations. Benefits to workers: medical, maternity, accident. Registration and compliance mechanisms. 4.4. Additional Legal Frameworks: Social security schemes for unorganized plantation workers. Kerala Plantation Labour Welfare Fund Act. Occupational health and safety rules. Land ceiling laws affecting plantations in Kerala.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is *strictly internal*. **Theory 5Hrs** Rcent advances in Farm Management. IoT. Micronutrient solution supply through automated drip irrigation. Various farms/plantations and associated disasters- Endosulfan issue. Mining in Plantation areas and associated floods and landslides. **Practical 10 Hrs** 1. Field visit to Plantations/ farms, Layams/houses of plantation workers, etc 2. Internship in farms, agricultural exporting companies, Food processing units, 3. Documentation and report submission of visits or internships

Suggested Assignment Topics- Theory

1. New changes in plantation land utilisation and labour laws
2. Man-wildlife conflict in plantation areas
3. Biodiversity of plantation areas.
4. Exploitation of plantation laws for other human enterprises

Suggested Assignment Topics- Practical

1. Beautification Garden making near the worker's camps
2. Biofencing of individual plots in layams
3. Conducting survey to find out the best HRM in plantation sector
4. Survey to find out the needs of labourers

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Agarwal, R.D. – *Organisation and Management*
2	Ashwathappa, K. – *Human Resource Management*
3	Bansil, P. C. (2015). *Plantation Crops: Tea, Coffee, Rubber and Cocoa (Economics of Agricultural Commodities Series)*. CBS Publishers & Distributors.
4	Bharadwaj, K. – *Production Conditions of Indian Agriculture*
5	Chawla, R.C. & Garg, K.C. – *Mercantile Law*
6	Chhabra, T.N. – *Human Resource Management*
7	Deodhar, S. B., Sankaran, S., & Punekar, S. D. (2022). Labour welfare, trade unionism and industrial relations (14th ed.). Himalaya Publishing House
8	Dhillon, W. S. (2022). *Plantation Crops in India*. NPH India
9	Flippo, E. B. (1984). Personnel Management (6th ed.). McGraw-Hill.
10	Government of India. (1951). The Plantations Labour Act, 1951 (Act No. 69 of 1951). Ministry of Labour & Employment.

11	Gulshan, P. C., & Kapoor, G. K. (2024). Business Law Including Company Law (23rd ed.). New Age International (P) Ltd.
12	Heady, E. O. (1952). Economics of Agricultural Production and Resource Use. Prentice-Hall.
13	Indian Council of Agricultural Research. (2008). Handbook of Agriculture (6th rev. ed.). Directorate of Knowledge Management in Agriculture.
14	Indian Council of Agricultural Research. (1960). Indigenous Agricultural Implements of India: An All-India Survey. ICAR.
15	Jain, S. C. (2017). *Farm Machinery: An Approach*. Standard Publishers.
16	Joseph, K. J., & Viswanathan, P. K. (Eds.). (2016). Globalisation, development and plantation labour in India. Routledge.
17	Krishna, K. S. R. (1995). *Human Resource Management in Agriculture*. Discovery Publishing.
18	Naik, B., Tarai, R. K., Sahoo, A. K., Sethy, B. K., & Samal, S. (2022). *A Textbook of Plantation Crops*. New India Publishing Agency.
19	Nair, K. R. (2006). The history of trade union movement in Kerala. Manak Publications.
20	Senthilkumar, T., Suthakar, B., & Manikandan, G. (2023). *A Textbook of Farm Machinery and Equipment: Principles and Practice*. Brillion Publishing.
21	Venkata Ratnam, C. S., & Dhal, M. (2017). Industrial relations (1st ed.). Oxford University Press.
22	Venkatesa Palanichamy, N., & Parimalarangan, R. (2025). *Textbook on Farm Management, Production and Resource Economics*. Brillion Publishing.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits and Surveys	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

This course is one of the promising one to get opportunity for a job in plantation sector and human resource management.

13	Stress Physiology		KU5DSEPLS306
DSE	Semester: 5	Hrs/week: 4 Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Understands the basic terms and concepts in plant stress physiology.
CO2	Acquire knowledge in various molecular, morphological and physiological processes related with stress condition.
CO3	Understand the physiological responses of plants towards stress
CO4	Understand the different types of hormones and their interactions in stress.
CO5	Learn about the application of plant stress in different field of plant science.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course is designed for the undergraduate students who wants to develop theoretical practical knowledge in plant stress.

- *First introductory module is giving an idea on the fundamental concepts in plant stress physiology along with glimpses of modern techniques.*
- *A deeper knowledge on abiotic stress is transacted through the theoretical session of the second module.*
- *Third module delves into the molecular mechanism behind the oxidative stress and hormonal and enzymatic management of the stress.*
- *Fourth module is designed to give more application-level knowledge on plant stress. .*

This course will help the student to get a strong foundation on plant stress physiology through classrooms sessions and exposures during demonstrations and field visits.

Course Objectives:

- Understand key concepts of plant stress physiology
- Explore physiological and molecular responses to various abiotic stresses
- Learn hormonal and oxidative regulatory mechanisms
- Discover recent advances using *Arabidopsis thaliana*
- Apply knowledge to agricultural and biotechnological contexts

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Fundamentals of Plant Stress Physiology (12 Hours) 1.1. Introduction to Plant Stress: Definition of stress physiology. Types of stress: Abiotic vs. Biotic. Concepts: Stress vs. strain (elastic and plastic). Acclimatization vs. tolerance. Overview of stressful environments (drought, salt, cold, heat, metal, anaerobic). 1.2. Morphological and Physiological Adaptations: Stress avoidance and tolerance mechanisms. Examples from xerophytes, halophytes, and mesophytes. Water-use efficiency and osmotic adjustment. Leaf, root, and stomatal adaptations. 1.3. Methods in Stress Physiology: Growth and physiological assays (e.g., electrolyte leakage, RWC). *Arabidopsis thaliana* as a model system: Advantages, genome, stress-related mutants. 1.4. Modern Methods in Stress Physiology: Tools and techniques: Transcriptomics (RNA-seq), gene editing (CRISPR), Imaging tools (thermal, chlorophyll fluorescence).
Module 2: Abiotic Stress Responses in Plants (12 Hours) 2.1 Water Deficit and Drought Stress: Mechanisms in xerophytes and mesophytes. Desiccation tolerance and avoidance. Molecular response in *Arabidopsis* (DREB, aquaporins). Energy balance and growth regulation 2.2 Salt Stress and Salinity Resistance: Salt injury and ion toxicity. Salt resistance in glycophytes and halophytes. SOS signaling pathway (*Arabidopsis*). Na^+/H^+ antiporters and osmolytes. 2.3 Temperature Stress: Chilling vs. freezing injury. Cold acclimatization, ice nucleation, and supercooling. Heat injury and heat shock proteins. Membrane stability and lipid remodeling 2.4 Other Abiotic Stresses: Heavy metal toxicity: Role of phytochelatins and metallothioneins. Detoxification strategies in *Arabidopsis.* Anaerobic stress and hypoxia tolerance. ROS generation and oxidative damage.
Module 3: Stress Signaling, Hormones, and Oxidative Regulation (12 Hours) 3.1. Hormonal Regulation of Stress Responses: ABA as a stress signal: biosynthesis, transport, signaling. Cytokinin: antagonistic role under drought/salt. Hormonal crosstalk: ethylene, salicylic acid, jasmonates. 3.2. Oxidative Stress and Redox Homeostasis: Sources and roles of ROS (H_2O_2, O_2^-). Lipid peroxidation and membrane damage. Antioxidant defense: 3.3. Major enzymes and scavengers: Enzymes: SOD, catalase, APX; Non-enzymatic scavengers: Ascorbate, glutathione. 3.4. Molecular Signaling Pathways: Calcium signaling, MAPKs. Stress-responsive transcription factors (DREB, NAC, MYB). Gene expression modulation during abiotic stress. Use of *Arabidopsis* mutants for signaling studies.
Module 4: Agricultural and Biotechnological Applications (12 Hours) 4.1. Climate-Resilient Agriculture: Agronomic strategies: irrigation, mulching, soil amendments. Stress-tolerant crop varieties. Integrated stress and pest management. Role of stress physiology in climate-smart agriculture. 4.2. Genetic and Biotechnological Approaches: Gene discovery using *Arabidopsis.* Transgenic approaches for stress tolerance (e.g., overexpression of HSPs, ion transporters). CRISPR-based genome editing in crop improvement. Biostimulants and plant growth-promoting rhizobacteria (PGPR). 4.3. Case Studies: Case: Drought-tolerant rice and salt-tolerant tomato. Translational research from *Arabidopsis* to crops. 4.4. Future Prospects: Role of remote sensing and drones (UAVs). Precision agriculture. Emerging trends: synthetic biology, systems biology.
Module 5. TEACH SPACE 15 Hrs : This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by

the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5Hrs** New researches and advancements in Stress Physiology. Stress impacts of Climate change and Disasters on major crop plants **Practical 10 Hrs** • Measurement of RWC, electrolyte leakage, stomatal index • Salinity and drought stress induction in seedlings • Estimation of antioxidant enzyme activity (e.g., catalase) • Observation of *Arabidopsis* stress mutants (if available)

Suggested Assignment Topics- Theory

1. Survey to understand the difference in stress for various individual plants in a community
2. Genes affected by stress
3. Mitigation strategies for reducing the stress in crop plants

Suggested Assignment Topics- Practical

1. Enzyme assays of various parts of a stressed plant
2. Survey to find out the most susceptible crop plants to various stresses

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Aftab, T., & Hakeem, K. R. (Eds.). (2022). Plant Abiotic Stress Physiology: Volume 2: Molecular Advancements. Apple Academic Press.
2	Bhattacharya, A. (2017). Abiotic Stress and Physiological Process in Plants. NIPA.
3	Dwivedi & Dwivedi (2005). Physiology of abotic stress in plants. Agro bios. India
4	https://sirsyedcollege.ac.in/crm/public/uploads/download_image/H8aTDrHeKuTogISO7SE1r80gjP2dmU.pdf
5	https://www.icar-crida.res.in/assets/img/Books/2011-12/Abiotic_Stress_in_Plants_-_Mechanisms_and_Adaptations_2011.pdf
6	Kumar, B. Sinha. (2022). Abiotic & Biotic Stress Management in Plants: Volume I: Abiotic Stress. CRC Press (co-published with NIPA).
7	Levitt J, 1981. Plant responses to environmental stresses (vol. I &II). Academic Press, New York & London
8	Panda S.K.(2002) Advances in Stress Physiology of Plants. Scientific Publishers, Jodhpur
9	Rai, G. K., Kumar, R. R., & Bagati, S. (Eds.). (2021). Abiotic Stress Tolerance Mechanisms in Plants. CRC Press.
10	Rao, N. K. Srinivasa, Shivashankara, K. S., & Laxman, R. H. (Eds.). (2016). Abiotic Stress Physiology of Horticultural Crops. Springer India.
11	Rout, G. R., & Das, A. B. (Eds.). (2022). Molecular Stress Physiology of Plants. Springer Nature.
12	Salisbury, F. B., & Ross, C. W. (1992). *Plant physiology* (4th ed.). Wadsworth Publishing Company.
13	Taiz, L., & Zeiger, E. (2002). *Plant physiology* (3rd ed.). Panima Publishing Corporation.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks

End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

The course equips the student with the conceptual understanding, technical skills, and analytical abilities required for careers in modern agriculture, plant biotechnology, and environmental management.

14	Weed Ecology		KU5DSEPLS307
DSE	Semester: 5	Hrs/week: 4 Theory + 0practical	Credits: 4

Course Pre-requisite:
1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes

CO1	Awareness on the ecological, biological, and economic aspects of weeds.
CO2	Skill in identification and classification of weeds in various habitats.
CO3	Skill in weed management practices, herbicide use, and integrated weed control approaches.
CO4	Gather awareness on local, regional, and global weed problems and their ecological implications.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This biology course designed for imparting knowledge on biology of weeds, their adaptive features and impacts on other flora and control measures.
• *First module is dealing with fundamental knowledge on weed plants and their classification.* • *In the second module the mechanism of survival by the weed is given in detail.* • *Third module listing out various weed management strategies.* • *Fourth module is giving glimpses of research and eradication programmes on major weeds of agroecosystems.*
This course will provide a comprehensive knowledge of weeds, their ecology and biology along with management strategies and control measures.

Course Objectives:

1. Understand the biology, ecology, and reproductive strategies of weeds
2. Learn how weeds interfere with crops and ecosystems
3. Explore management strategies and prevention techniques for invasive weeds
4. Gain hands-on experience in weed ecology research, mapping, and policy understanding

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Fundamentals of Weed Ecology (15 Hours)
1.1. Introduction to Weed Ecology: Definition and characteristics of weeds. Classification of weeds – annual, biennial, perennial. Difference between native and non-native (invasive) species.

1.2. Weed seed biology: Weed seed bank, dormancy, and germination ecology; weed indicators of soil and environment. Germination phases- Environmental factors influencing emergence and survival: Light, moisture, temperature, soil nutrients. Early growth strategies for rapid colonization. 1.3. Weed Reproduction and Spread: Reproductive strategies: Sexual (seeds), Asexual (rhizomes, stolons, tubers). Dispersal mechanisms: wind, water, animals, human activity. Seed bank dynamics and seed longevity. 1.4. Establishment of weeds- Major strategies of weeds in succession, colonization, adaptation, competition, and survival. Variation in strategies with variation in ecosystems.
Module 2: Weed Interactions and Competition (15 Hours) 2.1 Weed Interference with Crops: Concepts: Competition, allelopathy, parasitism. Competitive ability of common weed species. 2.2 Weeds and Crop Management: Economic threshold levels for weed interference. Yield losses in major crops due to weeds. Cropping systems and weed competition. Factors affecting crop–weed interactions: timing, density, resource overlap. 2.3 Ecological Consequences of Weeds: Impact on biodiversity and indigenous species. Effects on soil structure and nutrient cycling. Weeds as alternate hosts for pests and diseases. Disruption of native ecological processes. 2.4 Beneficial vs. harmful weed interactions: Beneficial aspects– soil stabilization, medicinal uses, fodder, and phytoremediation. Harmful effects on crop yield, biodiversity, forestry, fisheries, and human health.
Module 3: Weed Management Strategies and Practices (15 Hours) 3.1. Weed Management Techniques: Mechanical control: Tillage, mowing, hand weeding. Cultural control: Crop rotation, mulching, cover cropping. Chemical control: Herbicides – types, modes of action, resistance. Biological control: Predators, pathogens, competitive plants. Integrated Weed Management (IWM) principles. 3.2. Invasive Weeds: Prevention and Control: Invasive weed species and their characteristics. Early detection and rapid response (EDRR). Regulatory and policy frameworks (national and international). Community involvement and education 3.3. Weed Mapping Techniques: Introduction to weed mapping. Methods: quadrats, transects, GPS surveys. Use of GIS and remote sensing tools for mapping invasions. 3.4. Weed Control- Case study: Global and Indian success stories in weed eradication and biological control programs (*Eichhornia* in aquatic ecosystems, *Senna* in forests). Balancing weed control with biodiversity conservation.
Module 4: Applied Weed Ecology and Research Methods (15 Hours) 4.1 Investigating Weed Ecology: Research design in weed ecology. Field survey techniques and data collection. Sampling methods: frequency, density, biomass. Monitoring population dynamics over time 4.2 Applications in Agroecosystems: Role of ecological understanding in sustainable weed control. Agroecological approaches to weed suppression. Climate change and future weed threats. 4.3. Weeds in Agroecosystems: Weeds in agricultural, aquatic, and wasteland ecosystems. Invasive species in India (e.g., *Parthenium hysterophorus*, *Mikania micrantha*, *Lantana camara*). 4.4. Weeds in Agroecosystems of Kerala: Paddy (*Echinochloa colona*, *Cyperus rotundus*), coconut (*Mimosa pudica*), banana (*Ageratum conyzoides*), and plantation crops (*Chromolaena odorata*).
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for

this module is ***strictly internal***.
Theory 5Hrs
Pollinators of weeds. Major Diseases of weeds. Folk Medicines from weeds.
Practical 10 Hrs
1. Identification and record (Photograph) of **common weeds** from local fields, plantations, and aquatic habitats.
2. Preparation of a **field-based herbarium** (minimum 5 species) with ecological notes.
3. Observation of **seed dispersal structures** (anemochory, zoochory, hydrochory).
4. Germination studies on selected weed seeds under varied light and soil conditions.
5. Demonstration of **mechanical and manual weeding techniques**.
6. Comparison of weed population and diversity in **managed vs. unmanaged plots**.
7. Field visit to agricultural stations, Kerala Agricultural University (KAU) research plots, or local farms to study **weed management practices**.
8. Preparation of a **field report** with photographs and species list (submitted as part of practical record).

Suggested Assignment Topics- Theory
1. Successful stories of weed control from World. India and Kerala
2. Various programmes for eradication of weeds- advantages and Disadvantages
3. Diseases of weeds

Suggested Assignment Topics- Practical
1. Internship in weed management as a volunteer of forest department
2. Survey on diseases of weeds
3. Observation on native pollinators of weeds

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Gupta, O.P. (2016). *Weed Management: Principles and Practices*. Agrobios (India), Jodhpur.
2	Rao, V.S. (2000). *Principles of Weed Science*. Oxford & IBH Publishing, New Delhi.
3	Tiwari, J.P. (2014). *Weed Science*. Rastogi Publications, Meerut.
4	Subramaniyan, S. (2013). *Weed Science and Management*. Kalyani Publishers, Ludhiana.
5	Krishnamurthy, K.V. (2018). *Advanced Textbook on Weed Ecology*. Scientific Publishers, India.
6	Singh, H.P., Batish, D.R. & Kohli, R.K. (2006). *Allelopathy: Field Observations and Methodology*. Studium Press, New Delhi.
7	Clements, D.R. & DiTommaso, A. (2011). *Ecological Basis for Weed Management in Agroecosystems*. CRC Press.
8	Mohan, S. & Anitha, S. (2012). *Weed Management in Tropical Crops*. Kerala Agricultural University Press, Thrissur.
9	Radosevich, S.R., Holt, J. & Ghersa, C. (2007). *Ecology of Weeds and Invasive Plants*. Wiley-Blackwell.
10	Gopal, B. (2016). *Aquatic Plants and Weeds: An Ecological Approach*. Springer.
11	Sharma, G.P. (2014). *Invasive Weeds in the Tropics: Ecology and Management*. CABI Publishing.
12	Swaminathan, M.S. & Kochhar, S.L. (2019). *Environmental Studies: From Crisis to Cure*. McGraw-Hill.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments	➢ Lecturing
➢ Collaborative learning-Group	➢ ICT

discussion	➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

The course equips the student with the conceptual understanding, technical skills, and analytical abilities required for careers in modern agriculture and environmental management.

15	Seed Technology		KU5DSEPLS308
DSE	Semester: 5	Hrs/week: 4 Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the fundamentals of seed biology**,** including seed structure, types of seeds, importance, and seed dormancy, along with methods to overcome dormancy.
CO2	Apply the principles and techniques of seed production in agricultural and horticultural crops including seed multiplication and post-harvest handling.

CO3	Demonstrate knowledge of seed processing techniques such as drying, treatment, cleaning, grading, and storage, and identify equipment used in seed processing.
CO4	Evaluate different seed storage structures and packaging methods, understand labeling, record maintenance, marketing, and handling practices for maintaining seed quality.
CO5	Analyze the physiology of seed development, maturation, germination, and reserve mobilization, including the role of enzymes, hormones, and respiration in seed germination of major crops.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This is an introductory biology course designed for the undergraduates to get a foundation in various aspects of seed production, storage and dormancy breaking.

- *First module is dealing with the basics on seed biology and its dormancy.*
- *Second module delves into the standard methods for the production of seeds in various crops.*
- *Produced seeds are to be stored in good condition for future use and third module is giving the major processing protocols for that.*
- *Fourth module is giving idea on seed physiology and modern methods in seed production, certification and storage.*

This course will give opportunity for the students who have a basic interest in agriculture, entrepreneurship and innovation.

Course Objectives:

1. To understand the biological principles and practices of seed production
2. To apply techniques for seed processing, storage, and marketing
3. To explore modern advancements in seed science and biotechnological interventions.
4. To evaluate the role of seed technology in sustainable agriculture

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Fundamentals of Seed Biology and Dormancy 15 Hours

1.1 Introduction to seed biology: Definition, objectives, and scope. Historical development and significance in agriculture. Types of seeds: Orthodox vs. Recalcitrant; Monocot vs.

Dicot seeds. 1.2. Seed Characterization and Importance: Seed viability, purity, vigor, and moisture content. Role in crop improvement, food security, and biodiversity. 1.3. Seed Dormancy: Types of seed dormancy (physical, physiological, combinational). Methods to overcome dormancy: Scarification, stratification, chemical treatments. Advantages and disadvantages of dormancy. 1.4. Recent Advances in Seed Biology: Molecular regulation of dormancy (e.g., DOG1 gene in *Arabidopsis*). Genetic and epigenetic control of seed development. Use of transcriptomics and seed phenomics.
Module 2: Seed Production in Agricultural and Horticultural Crops `15 hrs 2.1. Principles and Methods of Seed Production Breeder, foundation, and certified seed classes. Genetic and physical purity maintenance. Pollination control and isolation distances 2.2. Seed Production in Major Crops. Cereal crops: Rice, wheat, maize. Vegetable crops: Pea, tomato, brinjal, cucumber. Techniques: Hand emasculation, bagging, hybrid seed production 2. 3. Seed Multiplication and Post-harvest Handling Seed multiplication ratios. Cleaning, grading, drying, and packaging. 2.4. Recent Advances in Seed Production: Hybrid seed technology and cytoplasmic male sterility (CMS). Biotechnology in seed production (marker-assisted selection, genome editing). Tissue culture and synthetic seeds.
Module 3: Seed Processing, Treatment, and Storage (15 Hours) 3.1 Seed Drying and Treatment: Importance of drying and optimum moisture content. Seed treatment methods: Chemical, biological, and polymer coating. Recent innovations: Seed priming, seed pelleting, bio-encapsulation. 3.2 Seed Cleaning and Equipment: Types of seed cleaning machines and their functioning. Pre-cleaning, air-screen cleaning, gravity separator, etc. 3.3 Seed Storage: Techniques and Challenges: Short-term vs. long-term storage. Factors affecting seed longevity: Temperature, RH, pests. Godown sanitation and monitoring tools 3.4 Seed Marketing and Quality Assurance: Seed certification, labeling, and tagging. Demand–supply chain and seed distribution networks.
Module 4: Seed Physiology and Modern Trends (15 Hours) 4.1 Seed Development and Maturation: Embryo development and physiological maturity. Seed coat formation and chemical changes during maturation. 4.2 Chemical Composition and Reserve Accumulation: Protein, lipid, and carbohydrate biosynthesis in seeds. Seed storage proteins and their agricultural relevance. 4.3 Seed Germination and Physiology: Phases of germination, imbibition, and radicle emergence. Factors affecting germination: Water, temperature, oxygen, hormones. Hormonal regulation: Role of GA, ABA, auxins. Role of embryonic axis and enzymes (amylase, protease). 4.4 Recent Advances in Seed Physiology: Use of genomics, proteomics in studying germination. Artificial seed technology and stress-resilient seed varieties. Seed respiration models and enzyme engineering.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. Theory 5Hrs Seedbank for conservation-germplasm collection. Seed viability and variation among crops and varieties. Seedless fruit production Practical 10 Hrs

1.	Demonstration of dormancy-breaking methods
2.	Seed viability testing (tetrazolium test)
3.	Study of seed structure and classification using microscope and specimens
4.	Field visit or virtual demonstration of seed production plots
5.	Preparation of seed production plan for a selected crop
6.	Seed treatment and coating demo
7.	Seed packaging, tagging, and record maintenance
8.	Germination testing in rice, pea, and wheat
9.	Estimation of amylase activity during germination
10.	Study of reserve mobilization during seedling growth
11.	Seed purity analysis
12.	Germination chamber setup and monitoring
13.	Use of seed moisture meters and vigor index calculation
14.	Visit to a seed testing laboratory / seed certification agency

Suggested Assignment Topics- Theory

1. Seed dormancy in crops and methods to break seed dormancy
2. Importance of seed dormancy
3. Seed viability
4. Various applications of seed storage

Suggested Assignment Topics- Practical

1. Seed jewellery making
2. Seed dormancy breaking experiments for different crops in various conditions

Sl. No	**Title/Author/Publishers of the Book specific to the programme**
1	Agrawal, P. K. (2019). *Principles of seed technology* (2nd ed.). Agri Gramodaya Publications. ISBN: 9789387067653
2	Agrawal, R. L. (2017). *Seed technology* (Revised ed.). Oxford & IBH Publishing. ISBN: 9788120413184
3	Bewley, J.D., Black, M. (1994). *Seeds: Physiology of Development and Germination*
4	Bhale, M. S. (2015). *Seed science and technology (2nd fully revised & enlarged ed.)*. Asha Book Agency. ISBN: 9789385047183
5	Bhale, M. S., & Khare, D. (2016). *Seed technology (Succinct edition)*. Scientific Publishers (India). ISBN: 9789386102430
6	Copeland, L.O., McDonald, M.B. (2001). *Principles of Seed Science and Technology*
7	Dadlani, M., & Yadava, D. K. (Eds.). (2023). *Seed science and technology: Biology, production, quality*. Springer Nature Singapore. https://doi.org/10.1007/978-981-19-5888-5
8	Databases: The Arabidopsis Information Resource (TAIR) for seed-related gene studies
9	Journals: *Seed Science Research*, *Plant Physiology*, *Journal of Seed Technology*
10	Khare, D., & Bhale, M. S. (2013). *Seed technology (2nd revised & enlarged ed.)*. Scientific Publishers (India). ISBN: 9788172338831
11	Kumar, R. (2018). *A competitive book of seed science and technology*. Kalyani Publishers. ISBN: 9789327225512
12	Padmavathi, S., Bharathi, A., & Mohan, R. (2012). *A textbook of seed science and technology*. NIPA (New India Publishing Agency). ISBN: 9789381450437
13	Sen, S., & Ghosh, N. (2012). *Seed science and technology*. Kalyani Publishers.

	ISBN: 9788127251581
14	Sharma, R. K. (2020). *A text book of seed technology*. Discovery Publishing House. ISBN: 9789350562176
15	Websites: ISTA (International Seed Testing Association), ICAR-NSC, SeedNet India Portal

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

The course equips the student with the conceptual understanding, technical skills, and analytical abilities related to seed technology which is required for careers in modern agriculture and environmental management.

16	Biotechnology and Basic Bioinformatics		KU6DSCPLS309
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Demonstrate understanding of core concepts and ethical issues in biotechnology.
CO2	Perform basic plant tissue culture techniques under aseptic conditions.

CO3	Explain and apply key steps in recombinant DNA technology and genetic manipulation.
CO4	Utilize bioinformatics tools for sequence analysis and biological data interpretation.
CO5	Apply biotechnological and computational approaches to solve basic biological problems.

<u>Mapping of Course Outcomes to PSOs/Pos</u>

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This undergraduate course provides foundational knowledge of biotechnology and bioinformatics, emphasizing key techniques such as plant tissue culture, recombinant DNA technology, and computational biology.

- *First module is dealing with the fundamentals of biotechnology, its historical evolution, interdisciplinary scope, and ethical dimensions.*
- *Second module focuses on the theoretical background and practical approaches of plant tissue culture, covering aseptic techniques, media preparation, culture types, and their wide-ranging applications in crop improvement and conservation.*
- *Third module module focuses on the theoretical background and practical approaches of plant tissue culture, covering aseptic techniques, media preparation, culture types, and their wide-ranging applications in crop improvement and conservation.*
- *Last module introduces computational tools and databases used to analyze biological data, including sequence alignment, molecular modeling, and genomics.*

This course will provide opportunity to bridge biological sciences with technology, preparing students for advanced studies and research applications in life sciences, healthcare, and agriculture.

Course Objectives:

1. To introduce the fundamental concepts, scope, and applications of biotechnology.
2. To familiarize students with the principles and practices of plant tissue culture.
3. To explain the tools and processes involved in recombinant DNA technology.
4. To provide an understanding of bioinformatics databases, tools, and their biological applications.
5. To develop laboratory and analytical skills relevant to biotechnology and bioinformatics research.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 +	5	35 (25 T and 10	65 (50 T and 15	100

			30)		P)	P)	

COURSE CONTENT

Module 1: Module I: Introduction to Biotechnology 10 hrs 1.1. Definition, Scope, and Branches of Biotechnology – Introduction, interdisciplinary nature, and importance in various sectors (Disease treatment and Medicine, Agriculture, Industry ,Environment and Biodiversity conservation.). 1.2. Historical Development and Milestones – Major discoveries and evolution of modern biotechnology. Old and New Biotechnology; Introduction to various sub disciplines of biotechnology with special emphasis to Microbial, Plant, Animal and Environmental biotechnology; 1.3. Tools and Techniques in Biotechnology – Overview of enzymes, vectors, cloning, and molecular tools. 1.4. Ethical, Legal, and Social Issues in Biotechnology – Biosafety, bioethics, and regulatory frameworks. Laboratory Safety and Good Laboratory Practices (GLP). Waste disposal.
Module 2: Plant Tissue Culture 12 hrs 2.1. Basic Concepts and Laboratory Requirements: Totipotency, differentiation, dedifferentiation and redifferentiation. Laboratory set up- Sterilization techniques, media preparation (MS medium), aseptic handling. 2.2. Types of Plant Tissue Culture – protocols of Callus culture, organ culture and protoplast culture. Micropropagation and Somatic embryogenesis. Significance of cell suspension culture, meristem culture and anather culture. 2.3. Applications of Plant Tissue Culture – Crop improvement, secondary metabolite production, germplasm conservation, and genetic transformation. 2.4. Troubleshooting and Contamination Control – Common problems and solutions in tissue culture practices.
Module 3: Recombinant DNA Technology 13 hrs 3.1. Basic Tools of rDNA Technology: Enzymes- Restriction enzymes, ligases. Vectors (plasmids- pBR 322, pUC. Cosmids and phagemids. BAC and YAC), and host systems. 3.2. Steps in Gene Cloning – Isolation, cutting, ligation, transformation, and screening of recombinant clones (GFP, Replica plating, Blue-white colony selection). 3.3. Expression of Recombinant Proteins – Expression systems, selection markers, and optimization of expression. 3.4. Applications of Genetic Engineering: Genomic library and cDNA library construction and its significance. Production of recombinant insulin, GM crops, vaccines, and gene therapy.
Module 4. Bioinformatics: 10 hrs 4.1. Introduction to bioinformatics: Aim, scope and research areas of Bioinformatics. Branches of Bioinformatics, Proteomics, Genomics, Metabolomics. General applications of Bioinformatics. 4.2. Bioinformatic Databases: Definition, scope, and biological databases (NCBI, EMBL, GenBank, DDBJ, PDB, UniProt). 4.3. Sequence Alignment and Analysis – Pairwise and multiple sequence alignment, BLAST, and FASTA algorithms. CLUSTALW/X. 4.4. Applications of Bioinformatics: Genome annotation, gene prediction, protein structure prediction. Drug discovery, phylogenetic analysis-PHYLIP, and molecular modelling
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for

this module is ***strictly internal***.

Theory 15Hrs

Techniques and tools of biotechnology: Electrophoresis – Agarose gel electrophoresis and Polyacrylamide gel electrophoresis and their uses. Blotting techniques: Northern, Southern and Western Blotting and their uses. Polymerase Chain Reaction, RT-PCR and qRT-PCR and their uses. DNA Fingerprinting; Molecular DNA markers - RAPD, RFLP, and SSR. DNA sequencing -Maxam –Gilbert method, Sanger's Sequencing.

GMPs Production- methodology, recombinant genes and the type of tools used in Bt Cotton, Golden Rice, Terminator Seeds, Flavr Savr Tomato, Banana with vaccines.

Practical 15 Hrs

1. In vitro culture of plant tissues – Demonstration of sterilization techniques, Media preparation, Selection, surface sterilization and Inoculation of explants.
2. Isolation of DNA from plant tissues
3. Demonstration of Agarose gel electrophoresis
4. Polymerase chain reaction (Demonstration)
5. Visit report to a biotechnology lab
6. Vectors-pBR322, pUC, Ti plasmid vectors. (Diagrams)
7. Website visits to databases –NCBI, EMBL,DDBJ,PDB
8. Demonstration of Sequence retrieval from databases and Sequence alignment
9. Construction of phylogenetic tree using PHYLIP
10. Sequence alignment using BLAST

Suggested Assignment Topics- Theory

1. Tissue engineering.
2. Next Gen- sequencing,
3. Gene editing tools- CRISPR-Cas9
4. Agrobacterium biology
5. Ti and Ri plasmids
6. T-DNA mutagenesis and T-DNA Tagging.

Suggested Assignment Topics- Practical

1. Preparation of Solutions and Buffers
2. Sterilization Techniques – Autoclaving,
3. Handling Micropipettes and Centrifugation –
4. Gel Electrophoresis
5. PCR Amplification (Demonstration/Simulation)

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Balasubramanian, D., Bryce, C. F. A., Dharmalingam, K., Green, J., & Jayaraman, K. (2004). Concepts in Biotechnology (2nd ed.). Universities Press.
2	Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.). Wiley-Interscience.
3	Bhojwani, S. S., & Razdan, M. K. (1996). Plant Tissue Culture: Theory and Practice. Elsevier.
4	Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction (7th ed.). Wiley-Blackwell.
5	Dubey, R. C. (2017). A Textbook of Biotechnology (6th ed.). S. Chand & Company Ltd.
6	European Bioinformatics Institute (EMBL-EBI). (n.d.). EMBL-EBI Training Resources.

	https://www.ebi.ac.uk/training/
7	Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press.
8	Karp, G. (2018). Cell and Molecular Biology: Concepts and Experiments (9th ed.). Wiley.
9	Kyoto Encyclopedia of Genes and Genomes (KEGG). (n.d.). KEGG Database. https://www.genome.jp/kegg/
10	Lesk, A. M. (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.
11	Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., & Darnell, J. (2021). Molecular Cell Biology (9th ed.). W. H. Freeman.
12	Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
13	National Center for Biotechnology Education (NCBE). (n.d.). Educational Biotechnology Resources. https://www.ncbe.reading.ac.uk/
14	Old, R. W., & Primrose, S. B. (1985). Principles of Gene Manipulation (4th ed.). Blackwell Scientific.
15	Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (8th ed.). Wiley-Blackwell.
16	Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press.
17	Singh, B. D. (2021). Biotechnology: Expanding Horizons (4th ed.). Kalyani Publishers.
18	Smith, R. H. (2013). Plant Tissue Culture: Techniques and Experiments (3rd ed.). Academic Press.
19	U.S. National Center for Biotechnology Information (NCBI). (n.d.). NCBI Databases. https://www.ncbi.nlm.nih.gov/
20	Watson, J. D., Myers, R. M., Caudy, A. A., & Witkowski, J. A. (2014). Recombinant DNA: Genes and Genomes – A Short Course (3rd ed.). W. H. Freeman.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Lab visits	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal practical examination	10

Employability for the Course / Programme

This course equips students with fundamental laboratory and computational skills essential for careers in biotechnology, bioinformatics, and allied research industries.

17	Phytophysiology		KU6DSCPLS310
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain major physiological functions and processes in plants.
CO2	Analyze how plants absorb and transport water and minerals.

CO3	Describe the biochemical pathways of photosynthesis and respiration.
CO4	Interpret the roles of hormones and environmental cues in plant growth and development.
CO5	Perform basic experiments related to plant physiology and analyze the results

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Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This explores the functional aspects of plants—their growth, metabolism, and response to environmental stimuli.

- *First module is dealing with the movement, absorption, and loss of water in plants and its physiological significance.*
- *Second module focuses on essential elements, their uptake, and the transport of organic and inorganic materials within plants.*
- *Third module provides an in-depth understanding of how plants convert light energy into chemical energy and utilize it in metabolic pathways.*
- *Plant growth patterns, hormonal regulation, and physiological responses to environmental factors are described in the fourth module.*

It equips students with conceptual and practical knowledge essential for further studies and research in plant sciences, agriculture, and biotechnology.

Course Objectives:

1. To introduce the fundamental physiological processes occurring in plants.
2. To understand mechanisms of water and nutrient transport in plants.
3. To study photosynthesis, respiration, and other energy-related processes.
4. To explore the role of plant growth regulators and environmental responses.
5. To develop skills in conducting physiological experiments and data interpretation.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	35 (25 T and 10 P)	65 (50 T and 15 P)	100

COURSE CONTENT

Module 1: Plant–Water Relations 10 Hours

1.1. Water Potential and Diffusion: Diffusion, DPD, Plasmolysis, Osmosis, Osmotic Pressure Concept of water potential- components, and measurement. Turgor pressure, Imbibition.
1.2. Absorption and Transport of Water – Pathways (apoplastic, symplastic, transmembrane) and root pressure.
1.3. Ascent of Sap – Cohesion–tension theory and supporting evidence.
1.4. Transpiration and Guttation – Mechanisms, factors affecting, and significance. Antitranspirants

Module 2: Mineral Nutrition and Translocation 12 Hours
2.1. Essential Mineral Elements – Criteria of essentiality and their physiological roles. Macro, micro and trace elements. Macro and Micro nutrients – Specific roles and deficiency symptoms, Hydroponics.
2.2.. Mechanism of Mineral Uptake – Passive and active absorption, ion exchange theory.
2.3. Nitrogen Metabolism – Nitrogen fixation, nitrate reduction, and ammonium assimilation.
2.4. Translocation of Solutes – Phloem transport, pressure flow hypothesis, and source–sink relationship.

Module 3: Photosynthesis and Respiration 14 Hours
3.1 Photosynthetic Pigments and Light Reactions – Structure and function of chloroplast; photosystems I & II; photophosphorylation
3.2. Carbon Fixation Pathways – C3, C4, and CAM pathways; photorespiration.
3.3. Factors Affecting Photosynthesis – Light, CO_2, temperature, and water; measurement of photosynthetic rate.
3.4. Plant Respiration – Glycolysis, Krebs cycle, electron transport system, and respiratory quotient

Module 4. Growth, Development, and Plant Movements 9 Hours
4.1. Growth and Development: Phases, measurement, and differentiation
4.2. Plant Growth Regulators (PGRs): Types, physiological effects, and commercial applications.
4.3. Photoperiodism and Vernalization: Concepts, types, and significance in flowering. Phytochrome - chemistry and physiological effects
4.4. Tropisms and Nastic Movements: Movements of locomotion, Curvature and Hygroscopic movements, Mechanisms and ecological importance

Module 5. TEACH SPACE 15 Hrs
This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.
Theory 15Hrs
Bioenergetics: Laws of Thermodynamics, High energy compounds and high energy nucleotides- ATP, NADPH, FADH and FMN with emphasis to the structure and function of ATP.
Other metabolisms in plants: Fatty Acid metabolism- beta Oxidation. Nitrogen Metabolism transamination and deamination.
Flower developments and fruit ripening, Senescence.
Practical 15 Hrs
1. Determination of water potential by tissue weight change method.
2. Rate of plasmolysis determination using Rhoeo leaf epidermal peelings
3. Relation between water absorption and transpiration.
4. Extraction and separation of leaf pigments by paper chromatography.
5. Effects of light intensity on photosynthesis by Wilmott's bubbler.

6.	Photo morphogenesis in seedlings grown under normal light and darkness.
7.	Demonstration of gravitropism using Klinostat.
8.	Determination of the rate of transpiration using Ganong's potometer.
9.	Kuhne's fermentation experiment. 10. Respirometer experiment.
10.	Study of auxin effect on coleoptile curvature / seed germination / apical dominance

Suggested Assignment Topics- Theory

1. History of photosynthesis
2. Plant physiologists and their discoveries
3. Major changes in metabolism during seed germination, bolting, flower development and fruit development and fruit ripening
4. Seed dormancy breaking
5. Applications of plant physiology in agriculture,

Suggested Assignment Topics- Practical

1. Experiments using physiological apparatus at different condition
2. Amylase during seed germination
3. Stress related metabolism and their assays
4. Pollen viability and seed viability study

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bidwell, R. G. S. (1979). Plant Physiology (2nd ed.). Macmillan.
2	Buchanan, B. B. (2015). The Arabidopsis Book: Plant Physiology Online. American Society of Plant Biologists. https://academic.oup.com/plphys
3	Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry and Molecular Biology of Plants (2nd ed.). Wiley Blackwell.
4	Devi, P. (2017). Plant Physiology. CBS Publishers & Distributors.
5	Heldt, H. W., & Piechulla, B. (2010). Plant Biochemistry (4th ed.). Academic Press.
6	Hopkins, W. G., & Hüner, N. P. A. (2009). Introduction to Plant Physiology (4th ed.). Wiley.
7	Khan Academy. (n.d.). Plant Physiology Tutorials. https://www.khanacademy.org
8	Moore, T. C. (1989). Biochemistry and Physiology of Plant Hormones (2nd ed.). Springer.
9	Mukherji, S., & Ghosh, A. K. (1995). Plant Physiology. Tata McGraw Hill.
10	National Center for Biotechnology Information (NCBI). (n.d.). Plant Physiology Journal Resources. https://www.ncbi.nlm.nih.gov
11	Nobel, P. S. (2005). Physicochemical and Environmental Plant Physiology (3rd ed.). Elsevier Academic Press.
12	Nobel, P. S. (2009). Physiochemical and Environmental Plant Physiology (4th ed.). Academic Press.
13	Noggle, G. R., & Fritz, G. J. (1983). Introductory Plant Physiology. Prentice-Hall.
14	Pandey, S. N., & Sinha, B. K. (2020). Plant Physiology (6th ed.). Vikas Publishing House.
15	Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2013). Biology of Plants (8th ed.). W. H. Freeman.
16	Salisbury, F. B., & Ross, C. W. (1992). Plant Physiology (4th ed.). Wadsworth Publishing.
17	Srivastava, H. S., & Singh, R. P. (2018). Plant Physiology and Biochemistry. Rastogi Publications.

18	Taiz, L., & Zeiger, E. (2002). Plant Physiology (3rd ed.). Sinauer Associates.
19	Taiz, L., & Zeiger, E. (2006). Plant Physiology (4th ed.). Sinauer Associates.
20	Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). Plant Physiology and Development (6th ed.). Sinauer Associates.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal practical examination	10

Employability for the Course / Programme

This course prepares students for careers in agriculture, plant research, environmental management, and allied life science industries by enhancing their understanding of plant physiological mechanisms.

18	Plant Ecology and Phytogeography		KU6DSCPLS311
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain how biotic and abiotic factors influence plant distribution and growth.
CO2	Describe and analyze key ecosystem functions such as productivity, energy flow, and nutrient cycling.

CO3	Evaluate the effects of disturbances, pollution, and climate change on vegetation dynamics.
CO4	Interpret patterns of plant diversity and distribution in India and globally.
CO5	Apply ecological and phytogeographic principles to conservation and restoration projects.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course explores the fundamental concepts of plant ecology (populations, communities, ecosystems, successional dynamics, abiotic and biotic factors) and also examines contemporary environmental problems along with fundamental phytogeography principles.

- *First module is dealing with how plants interact with their physical environment, how populations and communities are structured, and how ecosystems function.*
- *Second module examines how vegetation changes over time through succession and how disturbances and pollution influence community composition, ecosystem functioning, and stability in a rapidly changing environment.*
- *Third module contextualizes ecological theory within the diverse ecosystems of India and Kerala, emphasizing conservation of endemic and threatened flora.*
- *The final module expands the ecological perspective to spatial and temporal patterns of plant distribution, explaining global and Indian biogeographic regions and factors shaping vegetation evolution.*

Students will engage with both theoretical and applied components, preparing them to analyse vegetation patterns, assess ecological processes, and understand how conservation and management link to ecological and geographic principles.

Course Objectives:

1. To understand the basic ecological principles governing plant–environment interactions.
2. To study population, community, and ecosystem structure and functioning.
3. To evaluate the impact of anthropogenic activities including pollution and land-use change on vegetation.
4. To understand large-scale patterns of plant distribution (phytogeography).
5. To develop applied ecological perspectives relevant to Indian and Kerala ecosystems.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 +	5	35 (25 T and 10	65 (50 T and	100

			30)		P)	15 P)	

COURSE CONTENT

Module 1: Fundamentals of Plant Ecology 15 hrs 1.1. Basic Ecosystem structure: concepts on hierarchy of ecological units- species, population, community, ecosystem, biome and biosphere. Basic structure of ecosystem- - producers, consumers, decomposers. 1.2. Abiotic and biotic factors in plant ecology: light, temperature, water, soil, nutrients, wind. Climatic, edaphic and Topographic factors. Plant adaptations (hydrophytes, xerophytes, halophytes, parasites and epiphytes). 1.3. Ecosystem function: Food chains/webs. Primary productivity (GPP, NPP) and energy flow, Biogeochemical cycles (carbon, nitrogen, phosphorus). Decomposition and nutrient recycling. Ecological pyramids. Comparative account on productivity of major ecosystems. 1.4. Population ecology of plants and Community Ecology: population growth, regulation, carrying capacity, life history strategies, demographic analysis. Community ecology: species interactions (competition, facilitation, herbivory, parasitism). Ecological amplitude and law of tolerance. Ecological niche. Ecotones and edge effects.
Module 2: Vegetation Dynamics, Disturbance, Pollution, and Ecosystem Stability 10 hrs 2.1. Vegetation Succession**:** Primary and secondary succession, hydrosere and xerosere, models of succession (relay, initial floristics), climax concepts. 2.2. Disturbance Ecology and Stability**:** Natural (fire, flood) and anthropogenic disturbances; resilience, resistance, and feedback mechanisms maintaining ecosystem stability. . 2. 3. Pollution Ecology and Plant Responses**:** Types and sources of air, water, and soil pollution. Impacts on ecosystem. Physiological effects on plants (chlorosis, oxidative stress, reduced productivity). Bioindicators and biomonitoring (lichens, mosses, tree barks). 2.4. Ecosystem Function under Stress: Impact of pollutants and climate change on productivity and nutrient cycles. Restoration ecology: rehabilitation of degraded and polluted ecosystems. Phytoremediation and ecosystem detoxification.
Module 3: Plant Ecology in Indian and Kerala 3.1 Indian vegetation types: forests (evergreen, deciduous), grasslands, mangroves, wetlands. 3.2. Ecology of Western Ghats and Kerala ecosystems: endemism, montane grassland–shola mosaics, riparian systems. 3.3. Human impacts: deforestation, monoculture plantations, invasive species, urbanisation, and agro-ecosystems. 3.4. Ecological field and analytical methods: vegetation sampling, quadrat techniques, diversity indices, GIS and remote sensing applications.
Module 4. Phytogeography and Plant Distribution Patterns 10hrs 4.1. Phytogeography- definition- descriptive and dynamic – continental drift and age area hypothesis. Principles of Phytogeography- Species–Climate Equilibrium Principle. Endemism- paleo endemism, Neo-endemism and Epi-endemism. Centres of origin. Migration routes and dispersal mechanisms. 4.2. Biogeographic Regions of India and the World: major floristic kingdoms and vegetation zones. 4.3. Climate Change and Plant Distribution Shifts: Predictive models, threatened flora, altitudinal and latitudinal migrations. Assisted migration. Phenological and Biome shifts. Trophic and Mutualistic Mismatch due to climate change. 4.4. Conservation Biogeography: biodiversity hotspots (Western Ghats, Himalayas),

phytoendemism, and protected area networks.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 15Hrs** Ecosystem services (provisioning, regulating, cultural, supporting) and human dependence. Case studies on various types of pollution. Ganga River, Chernobyl, London and Delhi Smog, Endosulfan, Tajmahal Case studies on Restoration and conservation activites. Earth Summits and World protocols Chipko movement, Silent Valley Movement. India as a mega-diversity nation . Concept of Hot-spots of biodiversity and hotspots in India. Threats to biodiversity. In-situ and Ex-situ conservation of biodiversity – National Parks, Sanctuaries and Biosphere Reserves, Sacred groves and Botanic Gardens. Man-wildlife conflict. Biodiversity related agencies and activities-PBR, BMC. Conservation of Indigenous knowledge and Community participation. Utilization of GPS, Remote sensing and GIS to address environmental problems. **Practical 15 Hrs** 1. Visit a local polluted site and documentation of major pollutants/Reserve forest. 2. Study of plant community by quadrat method. 3. Study of ecological and anatomical modifications of xerophyte, hydrophyte, halophyte, parasite and epiphyte. 4. Estimation of DO and BOD and calculate the primary productivity of pond water. 5. Estimation of dissolved carbon dioxide in water 6. Knowledge of ecological instruments- hygrometer, rain gauge, anemometer, altimeter, luxmeter, wet and dry bulb thermometer, salinometer, water sampler, GPS 7. Visit to Local government office to read the PBR of the locality. 8. Participation in PBR related works

Suggested Assignment Topics- Theory

1. Conserved areas of Kerala and India
2. Geotegging and world heritage centres
3. Impact of flood/fire on plant communities
4. Adaptations of plants in mangroves
5. Biodiversity hotspots of India

Suggested Assignment Topics- Practical

1. PBR preparation
2. GIS application in college campus
3. Study of leaves/ roots etc with various applications or software
4. Water and soil testing to find out the major pollutants
5. Mapping of Indian vegetation types

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Aggarwal, S. K. (2009). Foundation course in biology (2nd ed.). Ane Books Pvt. Ltd.
2	Ambasht, R. S. (2023). A Textbook of Plant Ecology (16th ed.). CBS Publishers & Distributors.
3	Ambasht, R. S., & Ambasht, N. K. (2015). A textbook of plant ecology (15th ed.). CBS Publishers & Distributors Pvt. Ltd.
4	Arumugam, N., & Kumaresan, V. (2023). Plant Ecology. Saras Publication.
5	Bharucha, E. (2005). Textbook of environmental studies for undergraduate courses. Universities Press (India) Pvt. Ltd.
6	Chaubey, O. P., Sharma, A., & Prakash, R. (n.d.). Forest Ecology in India. Aavishkar

	Publishers.
7	Clark, R. S. (1992). Marine pollution (5th ed.). Oxford University Press.
8	Corlett, R. T., & Primack, R. B. (2011). Tropical Rain Forests: An Ecological and Biogeographical Comparison (2nd ed.). Wiley-Blackwell.
9	Cox, C. B., & Moore, P. D. (2005). Biogeography: An Ecological and Evolutionary Approach (8th ed.). Blackwell Publishing.
10	Gaston, K. J., & Spicer, J. I. (2004). Biodiversity: An Introduction (2nd ed.). Blackwell Publishing.
11	Gurevitch, J., Scheiner, S. M., & Fox, G. A. (2006). The Ecology of Plants (3rd ed.). Sinauer Associates.
12	Huston, M. A. (1994). Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press.
13	Jadhav, H. V. (n.d.). Environmental protection laws. Himalaya Publishing House.
14	Keddy, P. A. (2017). Plant Ecology: Origins, Processes, Consequences. Cambridge University Press.
15	Khitoliya, R. K. (2007). Environmental pollution: Management and control for sustainable development. S. Chand & Company Ltd.
16	Kormondy, E. J. (1989). Concepts of ecology (3rd ed.). Prentice-Hall of India Pvt. Ltd.
17	Kothari, A. (1997). Understanding biodiversity: Life, sustainability and equity (Tracts for the Times No. 11). Orient Longman Ltd.
18	Kumar, H. D. (1986). Modern concepts of ecology. Vikas Publishing House Pvt. Ltd.
19	Lambers, H., Chapin, F. S., & Pons, T. L. (2008). Plant Physiological Ecology (2nd ed.). Springer.
20	Mani, M. S. (Ed.). (1974). Ecology and Biogeography in India. Springer.
21	Misra, R., & Puri, G. S. (2021). Indian Manual of Plant Ecology. Scientific Publishers.
22	Nair, P. R. (1993). An Introduction to Ecology and Environmental Issues in the Western Ghats. (Report/Monograph). Centre for Earth Science Studies.
23	Pimm, S. L. (2011). The Rapid Rise of Invasive Species (Report). United Nations Environment Programme.
24	Pullaiah, T., Krishnamurthy, K. V., & Bahadur, B. (Eds.). (2019). Ethnobotany of India (5 vols.). Apple Academic Press.
25	Rajbala. (2025). Environmental Biology and Phytogeography. KD Publications.
26	Sannigrahi, S., Chakraborti, S., Joshi, P. K., et al. (2019). Effects of Green Revolution led agricultural expansion on net ecosystem service values in India. arXiv. https://arxiv.org/abs/1909.10742
27	Upadhyay, S., Mondal, T., Pathak, P. A., Roy, A., Bhattacharya, S., & Sen, S. (2018). A network theoretic study of potential movement and spread of Lantana camara in Rajaji Tiger Reserve, India. arXiv. https://arxiv.org/abs/1808.03160
28	Verma, V. (2011). Plant Ecology. Ane Books Pvt Ltd.
29	Whittaker, R. H., Levin, S. A., & Root, R. B. (1973). Evidence for the existence of risk-spreading and bet-hedging strategies in plants. Proceedings of the National Academy of Sciences, 70(5), 1335-1338.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Filed visit to polluted areas ➢ LSG office visit to see the PBR	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks

End Semester Evaluation ESE	**65**
• University Examination	50
• Practical examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal practical examination	10

Employability for the Course / Programme

This course equips students for employment or further study in fields such as environmental consultancy and ecological impact assessment; forest, agriculture, and biodiversity management; and climate change and pollution research.

19	**Evolution and Plant Breeding**		**KU6DSEPLS312**
DSE	**Semester: 6**	**Hrs/week: 4 Theory**	**Credits: 4**

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Demonstrate an understanding of evolutionary theories and their application to plant science.

CO2	Identify key evolutionary events and their significance in plant diversification.
CO3	Evaluate different breeding methods and their relevance to crop improvement.
CO4	Utilize knowledge of genetics and evolution to address agricultural challenges.
CO5	Integrate ethical and ecological considerations in plant breeding and conservation programs.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This undergraduate course introduces students to the scientific foundations of biological evolution and their practical applications in the genetic improvement of plants.

- *First module explores how life originated and evolved through various scientific theories and discusses the molecular and fossil evidence supporting evolutionary theory.*
- *Second module explores how evolutionary mechanisms operate at different scales—from small genetic changes within populations to large-scale evolutionary trends leading to the formation of new species.*
- *Third introduces the goals, principles, and genetic foundations of plant breeding.*
- *Fourth module discusses recent advances in plant breeding, integrating molecular tools, genomics, and bioinformatics for crop improvement and sustainability.*

The course aims to build a bridge between evolutionary biology and applied plant science for sustainable agriculture and biodiversity conservation.

Course Objectives:

1. Explain the fundamental principles and mechanisms of evolution in plants and animals.
2. Analyze the role of genetic variation and selection in shaping evolutionary processes.
3. Describe the historical and modern approaches to plant breeding.
4. Apply genetic principles to the improvement of crop plants.
5. Appreciate the importance of biodiversity and germplasm conservation for sustainable breeding programs.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60 + 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Origin of Life and Theories of Evolution 12 hours

1.1. Origin of Life: Theories of abiogenesis and biogenesis; Miller–Urey experiment; origin of cells. Oparin's bubble hypothesis. The origin of Prokaryotes and Eukaryotes ; the earliest cells LUCA. Endosymbiotic theory by L. Margulis

1.2.Pre-Darwinian Theories: Use and Disuse theory by Lamark; Germplasm theory by Weisman and De Vries. 1.3. Darwinian Theories: Darwinism: HMS Beagle and its voyages- Natural Selection theory Darwin and Wallace- examples of plants cited by Wallace and Darwin. Neo-Darwinism and other modern concepts of evolution. Molecular evidences for Darwinism Modern Synthetic Theory of evolution. 1.4. Mechanisms of Evolution: Mutation, recombination, genetic drift, migration, and natural selection. Evidence for Evolution: Fossil records, comparative anatomy, embryology, atavism biogeography, and molecular evidence.
Module 2: Microevolution, Macroevolution, and Speciation 12 Hours 2.1. Evolution: Definition- classical and modern concepts Evolution: Definition- classical and modern concepts. Macro and Microevolution, Convergent and Divergent Evolution, Retrogressive and Progressive Evolution. 2.2. Micro and macroevolution: Microevolution-Genetic variation within populations; ; Equilibrium of Gene frequencies and Hardy Weinberg law. Changes in Gene Frequencies act as elementary forces of evolution -Mutation, selection, migration, genetic drift, non-random mating. Macroevolution: Patterns and rates of large-scale evolutionary change; adaptive radiation; evolutionary trends in plants. 2.3. Isolation and Speciation: Isolation Mechanisms: Prezygotic and postzygotic barriers; reproductive isolation in plants. Types of speciation (allopatric, sympatric, parapatric, peripatric); role of natural selection and genetic drift in species formation. 2.4. Mutation and Evolution: Polyploidy and Evolution, Hybridization and Evolution, Polygenic inheritance –heritability and selection-
Module 3: Principles and Methods of Plant Breeding 12 Hours 3.1. **History and Objectives:** Domestication of crops; contributions of Mendel and Vavilov; objectives of modern breeding. **3.2.Genetic Basis of Breeding:** Variation, heritability, combining ability, and selection response. **3.3.Breeding Methods for self pollinated and cross pollinated crops:** Pure-line selection, mass selection, hybridization, heterosis, and recurrent selection. **3.4.Mutation and Polyploidy Breeding:** Induced mutation and chromosome manipulation in crop improvement.
Module 4. Modern Approaches and Applications in Plant Breeding 12 hours 4.1. Biotechnology in Plant Breeding: Molecular Breeding Techniques: Marker-assisted selection (MAS), QTL mapping, and genomic selection. Genetic engineering, CRISPR-Cas systems, and transgenic crops. 4.2. Breeding for Biotic and Abiotic Stress Tolerance: Drought, salinity, pest, and disease resistance. 4.3. Germplasm Conservation and Ethical Issues: Gene banks, intellectual property rights, and biosafety. 4.4. **Plant variety protection, Farmer‘s right and plant breeders rights.**
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. Theory 5Hrs Genetic resources-Centres of diversity, Origin of crop plants, Domestication, Conservation, Plant introduction and acclimatization. Plant quarantine measures. Methods of Breeding-Hydridization-Heterosis and Selection, (Pedigree, Mass, Pureline and Clonal). Major plant breeding Institutes in India and its contributions. Achievements in Rice, Wheat, Cotton,

Sugarcane, Potato and Tomato. Practical 10 Hrs 1. Demonstration of Emasculation and hybridization 2. Vegetative propagation – budding, layering and grafting 3. Visits to hybridisation institutes

Suggested Assignment Topics- Theory

1. Successful hybrids of crops and their properties
2. Genetic erosion due to breeding
3. Advantage and disadvantages of Plant Breeding
4. New World crops

Suggested Assignment Topics- Practical

1. Breeding in ornamental plants
2. Pisum Cultication for rediscovery of Mendelian principles

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Acquaah, G. (2012). *Principles of Plant Genetics and Breeding* (2nd ed.). Wiley-Blackwell.
2	Allard, R. W. (1999). *Principles of Plant Breeding* (2nd ed.). John Wiley & Sons.
3	Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B., & Patel, N. H. (2007). *Evolution*. Cold Spring Harbor Laboratory Press.
4	Futuyma, D. J., & Kirkpatrick, M. (2017). *Evolution* (4th ed.). Sinauer Associates.
5	Singh, B. D. (2015). *Plant Breeding: Principles and Methods* (10th ed.). Kalyani Publishers.
6	Sleper, D. A., & Poehlman, J. M. (2006). *Breeding Field Crops* (5th ed.). Blackwell Publishing.
7	Stebbins, G. L. (1971). *Processes of Organic Evolution*. Prentice-Hall.
8	Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2013). *Biology of Plants* (8th ed.). W. H. Freeman.
9	Snustad, D. P., & Simmons, M. J. (2020). *Principles of Genetics* (8th ed.). Wiley.
10	Hancock, J. F. (2012). *Plant Evolution and the Origin of Crop Species* (3rd ed.). CABI.
11	**Journals and Reports**
12	Tanksley, S. D., & McCouch, S. R. (1997). Seed banks and molecular maps: Unlocking genetic potential from the wild. *Science, 277*(5329), 1063–1066.
13	Tester, M., & Langridge, P. (2010). Breeding technologies to increase crop production in a changing world. *Science, 327*(5967), 818–822.
14	Gepts, P. (2002). A comparison between crop domestication, classical plant breeding, and genetic engineering. *Crop Science, 42*(6), 1780–1790.
15	McCouch, S. R. (2004). Diversifying selection in plant breeding. *PLoS Biology, 2*(10), e347.
16	Kumar, A., & Singh, P. (2016). Marker-assisted selection in crop plants: Concepts and practice. *Plant Breeding, 135*(1), 1–10.
17	Henry, R. J. (2012). *Plant Genotyping: The DNA Fingerprinting of Plants*. CABI.
18	FAO. (2010). *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Food and Agriculture Organization of the United Nations.
19	IPGRI. (2003). *Descriptors for Genetic Resources Documentation*. International Plant Genetic Resources Institute.
20	Falconer, D. S., & Mackay, T. F. C. (1996). *Introduction to Quantitative Genetics*. Longman.
21	Coyne, J. A., & Orr, H. A. (2004). *Speciation*. Sinauer Associates.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal Practical Examination	10

Employability for the Course / Programme

This course equips students with a deep understanding of biodiversity, adaptation, and genetic manipulation for sustainable agriculture.

20	Research Methodology and Biostatistics		KU6DSEPLS313
DSE	Semester: 6	Hrs/week: 4 Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Formulate research questions, hypotheses, and study designs.
CO2	Collect, organize, and summarize scientific data effectively.

CO3	Apply appropriate statistical methods to analyze biological data.
CO4	Interpret and present research findings using statistical and graphical tools.
CO5	Demonstrate understanding of research ethics and report writing standards.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This biology course provides foundational knowledge and practical skills in research design, data collection, analysis, and interpretation.
• *First module is dealing with the basic principles of research, scientific thinking, and the systematic approach to investigation.* • *Second module emphasizes on different types of research designs and techniques of data collection in biological sciences.* • *Third module focuses on statistical concepts, data summarization, and hypothesis testing essential for biological research.* • *Last module covers data management, use of statistical software, and effective research communication and publication.*
This course integrates research methodology with statistical reasoning to help students plan, execute, and present scientific investigations effectively and ethically.

Course Objectives:

1. To understand the fundamental principles and processes of scientific research.
2. To develop skills in designing, conducting, and reporting research studies.
3. To learn various data collection methods and statistical tools for biological data analysis.
4. To familiarize students with software and computational tools used in biostatistics.
5. To cultivate critical thinking and ethical practices in research

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Introduction to Research Methodology 12 Hours

1.1 Definition of research: types (basic, applied, quantitative, qualitative). Analytical vs Descriptive, Basic vs Applied, Research Methods vs Methodology.

1.2. Conceptualization a research problem: Research Process – Steps in research, research questions, and objectives formulation**.** Developing a research model, Validation of the

proposed model with standard procedures and attributes 1.3. Literature Review and Research Gap Identification: Sources, search strategies, and referencing styles. Search engines. Literature-review and its consolidation 1.4. Research Ethics and Plagiarism: Ethical issues, informed consent, intellectual property rights. Commercialization and Royalty. Ethics during Report Writing- need of acknowledgements, citations, research grants/ fellowships, bibliography.
Module 2: Research Design and Data Collection 12 Hours 2.1. Research design and implementation: Research Designs – Experimental, observational, descriptive, and analytical designs. 2.2. Sampling Methods: Probability and non-probability sampling, sample size determination. 2. 3. Data Collection Methods: Questionnaires, interviews, experiments, surveys, field studies. Observation and Data acquisition., Processing and Analysis Strategies 2.4. Data quality check: Importance of measurement and unts. Reliability, validity, and types of scales.
Module 3: Biostatistics – Descriptive and Inferential Statistics 14 Hours 3.1. Types of Data and Data Presentation – Qualitative and quantitative data, tables, graphs, charts. Various types graphs, charts and tables. A comparative account on merits and demerits of each type 3.2. Measures of Central Tendency and Dispersion – Mean, median, mode, range, variance, standard deviation. A comparative account on merits and demerits of each type 3.3. Correlation and Regression Analysis: Linear regression, correlation coefficients, and interpretation. A comparative account on types of correlation. 3.4. Hypothesis Testing: Null and alternative hypotheses, t-test, chi-square test, ANOVA, and p-values.
Module 4. Data Analysis Tools and Research Reporting 8 Hours 4.1. Introduction to Statistical Software – Use of Excel, SPSS, R, and online statistical tools 4.2. Data Interpretation and Visualization – Graphs, charts, tables, and figures. Photos and videos as data in biological science. 4.3. Scientific Writing and Report Preparation – Structure of a thesis/paper, abstracts, citations. 4.4. Presentation and Publication of Research – PowerPoint presentations, poster preparation, publication ethics.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 2Hrs** Computer and AI in research planning and implementation. merits and demerits. **Practical 10 Hrs** 1. Graph and Table preparation using computers and spread sheets or AI software 2. Work out problems on measures of central tendencies, measures of dispersion. Chi-square analysis, both manually and using computer software. 3. Preparation of power point presentations and poster preparations using computer software and mobile applications

Suggested Assignment Topics- Theory

1. Various research designs applicable to agricultural research
2. Ethics in biological research
3. IPR and Biology
4. Ethics and Biotechnology

5. Electron microscopic images and biological research
6. Application of statistics in biological research

Suggested Assignment Topics- Practical

1. Preparation of graphs and charts using AI
2. Microscopy and visualisation of images using software

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Altman, D. G. (1991). Practical Statistics for Medical Research. Chapman and Hall.
2	Bland, M. (2015). An Introduction to Medical Statistics (4th ed.). Oxford University Press.
3	Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). SAGE Publications.
4	Dawson, C. (2019). Introduction to Research Methods: A Practical Guide for Anyone Undertaking a Research Project (5th ed.). Robinson.
5	Glantz, S. A. (2011). Primer of Biostatistics (7th ed.). McGraw-Hill Education.
6	GraphPad Software. (n.d.). Statistical Analysis Tools. https://www.graphpad.com
7	Kothari, C. R., & Garg, G. (2019). Research Methodology: Methods and Techniques (4th ed.). New Age International.
8	Kumar, R. (2019). Research Methodology: A Step-by-Step Guide for Beginners (5th ed.). SAGE Publications.
9	Motulsky, H. (2018). Intuitive Biostatistics (4th ed.). Oxford University Press.
10	National Center for Biotechnology Information (NCBI). (n.d.). PubMed Database. https://pubmed.ncbi.nlm.nih.gov
11	Pagano, M., & Gauvreau, K. (2018). Principles of Biostatistics (2nd ed.). CRC Press.
12	Pandey, P., & Pandey, M. M. (2021). Research Methodology: Tools and Techniques (4th ed.). Bridge Center.
13	R Core Team. (2024). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. https://www.r-project.org
14	Rosner, B. (2016). Fundamentals of Biostatistics (8th ed.). Cengage Learning.
15	Sokal, R. R., & Rohlf, F. J. (2012). Biometry: The Principles and Practice of Statistics in Biological Research (4th ed.). W. H. Freeman.
16	SPSS Tutorials. (n.d.). IBM SPSS Statistics Documentation. https://www.ibm.com/spss
17	Thirumalaisamy, R. (2020). Research Methodology in Biological Sciences. Scientific Publishers.
18	Walliman, N. (2018). Your Research Project: Designing and Planning Your Work (4th ed.). SAGE Publications.
19	Wayne, D. W., & Chad, L. C. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences (11th ed.). Wiley.
20	Zar, J. H. (2010). Biostatistical Analysis (5th ed.). Pearson.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Statistical calculations in the classroom ➢ Collaborative learning-Group discussion ➢ Demonstrations using computers	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

and other software	

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Practical examination	10

Employability for the Course / Programme

This course enhances students' analytical, statistical, and research-writing skills, preparing them for roles in research, academia, and data-driven industries.

21	FLORICULTURE AND OLERICULTURE		KU6DSEPLS314
DSE	Semester: 6	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the **fundamental principles** of floriculture, olericulture, and landscaping, including propagation, soil, nutrient, pest, and disease management.

CO2	Demonstrate knowledge of **commercial flower and vegetable crop production** techniques under both open field and protected environments.
CO3	Apply **post-harvest technologies** for handling, storage, dehydration, drying, and packaging of flowers and vegetables.
CO4	Analyze and design **landscape gardens** of different styles and special types
CO5	Evaluate **entrepreneurial opportunities and value addition** in floriculture and olericulture, including processing, marketing, trade, and export potential.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course provides a comprehensive overview of floriculture, olericulture and landscaping

- *First module explores the basics of flower and vegetable cultivation.*
- *Second module delves into commercial scale flower production.*
- *Module three focuses on large-scale vegetable production.*
- *Fourth module comprises of the principles and styles of landscape garden design.*

This course will provide you opportunities to learn various techniques in commercial floriculture, olericulture and landscaping.

Course Objectives:

1. To provide fundamental knowledge of floriculture and olericulture practices suited to South Indian conditions.
2. To understand production technology, pest and disease management, and post-harvest handling.
3. To develop awareness of commercial potential, value addition, and sustainable practices.
4. To introduce students to regional crop protocols and market linkages.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	5	30	70	100

COURSE CONTENT

Module 1: INTRODUCTION TO FLORICULTURE AND OLERICULTURE 8 Hrs

1.1 Introduction to floriculture and olericulture, importance and scope, history, classification of vegetables (fruit, leafy, root, and tubers) and flowers (cut flowers, loose flowers, foliage).

1.2. Principles of flower/vegetable production. propagation methods: seeds, cutting, grafting and

tissue culture. Role of climate, soil, and regional resources 1.3. Soil, Water and Nutrient Management Basics. Soil Fertility management and pH adjustment. Strategies of Pest and disease management in floriculture and olericulture. 1.4. Global and national trends in olericulture and floriculture; export potential.
Module 2: COMMERCIAL FLORICULTURE 15 Hrs 2.1. Scope and importance of commercial floriculture in India. Major crops for domestic and export. Role of season, variety selection, planting density, and harvesting practices. Common pests (thrips, aphids, mites, caterpillars). Control measures and integrated Pest management (IPM). Fungal, bacterial, and viral diseases (powdery mildew, wilt, mosaic). 2.2. Production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, jasmine and anthurium. production techniques for bulbous ornamentals. 2. 3. Production techniques of flowers and foliage filler materials, growing of flowers under protected environments such as glass house, plastic house. 2.4. Postharvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers,
Module 3: COMMERCIAL OLERICULTURE 15 Hrs 3.1 Scope and importance of commercial olericulture in Southern India. Various cropping systems (intercropping, succession cropping). Pests of solanaceous and cucurbitaceous vegetables. Organic and chemical control measures. Diseases of tomato, brinjal, okra, and gourds. Integrated Disease Management (IDM) strategies. Use of resistant varieties and biological control. 3.2. Production techniques of commercial vegetable crops tomato, cucumber, cluster bean, brinjal, ladies finger for domestic and export market, 3.3. Production techniques of vegetables under protected environments such as glass house, plastic house, roof tops. 3.4. Postharvest technology management of vegetables
Module 4. LANDSCAPING 10 hrs 4.1. Principles of Landscape gardens, land scape design, styles of garden 4.2. Characteristics of Japanese gardens, Mughal, gardens, Hindu gardens and Buddhist gardens 4.3. Salient features of English garden, French and Persian garden and Italian gardens 4.4. Types of gardens- Lawn and hedge plants, roof garden, bog garden, sunken garden, clock garden
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5Hrs** Entrepreneurship in Horticulture **-** Value Addition & Processing Scope of entrepreneurship in floriculture and olericulture, Government schemes, subsidies, and policies supporting horticulture start-ups. Successful stories in olericulture and floriculture. Nutraceuticals and functional foods from vegetables and flower. **Practicals 7 Hrs** 11. Vertical gardening 12. Hydroponics 13. Potting mixture preparation 14. Preparation of fungicides 15. Collection and identification major diseases 16. IPM and IDM of crops

Suggested Assignment Topics- Theory

1. Different innovations- Bonsai, terrarium, etc
2. Features of different gardens

3. Exotic flowers and vegetables and their acclimatisation procedures

Suggested Assignment Topics- Practical

1. Visit to different flower/ vegetable gardens
2. Documentation of different gardens
3. IPM and IDM of new varieties
4. Survey to find out diseases and symptoms

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Kannan, & Ranchana. (2016). Objective Floriculture. New India Publishing Agency.
2	Lal, L. (2020). Textbook of Landscaping. AgroTech Books.
3	Loehrlein, M. (2021). Sustainable Landscaping: Principles and Practices (2nd ed.). CRC Press.
4	Randhawa, G. S. (2015). Floriculture in India. Bio-Green.
5	Shankaraswamy, J. (2018). Comprehensive Floriculture. Jaya Publishing House.
6	Singh, A. K., & Sisodia, A. (2020). Textbook of Floriculture & Landscaping. New India Publishing Agency.
7	Syamal, M. M. (2015). Commercial Floriculture. NHP India.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical examination	10

Employability for the Course / Programme

Learners will be equipped with fundamental and applied knowledge of floriculture, olericulture and landscape design—enabling them to pursue careers in commercial flower and vegetable production.

22	Agroecology		KU6DSEPLS315
DSE	Semester: 6	Hrs/week: 4Theory + 0 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Ability to identify ecological processes that underpin sustainable agricultural practices.

CO2	Gaining insight into nutrient, water, and energy flows in different agroecosystems.
CO3	Develop skills in evaluating soil health and conservation strategies.
CO4	Appreciate the significance of biodiversity in enhancing ecosystem resilience.
CO5	Equipped to recommend sustainable management strategies based on agroecological principles

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course introduces the ecological principles and practices that enhance sustainability, productivity, and biodiversity in agricultural systems.

- *First module provides an understanding of the growing need for agroecological approaches to ensure food security and sustainability.*
- *The fundamental principles, processes, and ecological interactions that define agroecosystems are described in the second module,*
- *Third module examines the ecological aspects of soil, nutrient dynamics, and resource conservation for sustainable agriculture.*
- *Fourth highlights the role of biodiversity, traditional knowledge, and conservation initiatives in building resilient agroecosystems.*

This course will provide you opportunities to enhance the quality of agroecosystems through the knowledge gained by the completion of this course.

Course Objectives:

1. To understand the ecological foundations underlying modern and traditional agroecosystems.
2. To analyze principles and concepts governing the interactions within agricultural environments.
3. To explore soil ecology, nutrient dynamics, and water management strategies in agroecosystems.
4. To examine the importance of agrobiodiversity conservation and its role in sustainable food systems.
5. To apply ecological knowledge for the design and management of resilient and sustainable farming systems.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 +	5	30	70	100

			30)				

COURSE CONTENT

Module 1: Foundations of Agroecology (12 Hours) 1.1. Human population growth and its impact on agricultural systems: Malthusian principle 1.2. Food security and food safety: challenges and opportunities. Need of sustainable agroecosystems for the food safety. 1.3. Sustainable agroecosystems for food safety and long-term productivity 1.4. Significance, scope, and interdisciplinary nature of agroecosystem studies
Module 2: Principles and Concepts in Agroecology (12 Hours) 2.1.Principles and characteristics of agroecosystems: case studies (paddy, forest gardens, plantations). 2.2.Energy flow, water, and nutrient cycling in agroecosystems. 2.3.Pest and weed ecology, population dynamics, and integrated pest management (IPM). 2.4.Comparative productivity and sustainability of various agroecosystems
Module 3: Soil Ecology and Resource Management (12 Hours) 3.1. Soil types, properties, and classification in relation to agroecosystem function 3.2. Nutrient cycling: macro and micronutrients, pH balance, nitrogen and decomposition processes 3.3. Soil health, beneficial organisms, and nutrient management strategies 3.4. Soil and water conservation: contour farming, cover cropping, windbreaks, and buffers
Module 4. Agrobiodiversity and Conservation for Sustainability (12 Hours 4.1. Indigenous crop varieties and biodiversity conservation (rice, pepper, coconut, banana, mango, etc.). 4.2. Landscape ecology, habitat management, and impacts of agriculture on biodiversity. 4.3. Conservation initiatives: seed banks, genetic resources, IPR, GI tagging, and Access Benefit Sharing (ABS). 4.4. Sustainable practices, agro-ecotourism, and case studies (e.g., EPA's Agriculture in Concert with the Environment).
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 4Hrs** Saline agroecosystems (Kaippad) and its peculiarities. Innovative ideas on paddy- prawn mixed cultivation. Hydroponics and aeroponics as an agroecosystem. **Practical 8 Hrs** 1. Soil sampling and analysis for organic carbon, N, P and K. 2. Calculation of soil moisture content and water holding capacity of different soil samples 3. Estimation of soil pH, EC and TDS. 4. Documentation of the cultivated local varieties of any two crop plants (submit report with specimens/geotagged photographs).

Suggested Assignment Topics- Theory

1. Diversity in cultural practices and management in various agroecosystems. (Coconut, paddy, tapioca)
2. Biodiversity depletion and genetic erosion due to agriculture and plant breeding.

Suggested Assignment Topics- Practical

1. Survey of biodiversity various agriculture lands
2. Agrobiodiversity documentation
3. Field trip to agriculture research institutes.

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Altieri, M.A. (1995). *Agroecology: The Science of Sustainable Agriculture.* Westview Press.
2	Altieri, M.A., & Nicholls, C.I. (2017). *Agroecology: A Transdisciplinary, Participatory and Action-oriented Approach.* CRC Press.
3	Amaresan, N., Krishna Kumar, A., Sankaranarayanan, K., Annapurna, & Senthil Kumar, M. (Eds.). (2020). *Beneficial microbes in agro-ecology: Bacteria and fungi.* Academic Press.
4	Conway, G.R. (1987). *The Properties of Agroecosystems.* Agricultural Systems, 24(2), 95–117.
5	Drinkwater, L.E., & Snapp, S.S. (2007). *Nutrient Cycling in Agroecosystems: Balancing Food and Environmental Objectives.* Frontiers in Ecology and the Environment, 5(5), 303–311.
6	FAO (2018). *The 10 Elements of Agroecology: Guiding the Transition to Sustainable Food and Agricultural Systems.* Food and Agriculture Organization of the United Nations.
7	Gliessman, S.R. (2015). *Agroecology: The Ecology of Sustainable Food Systems.* CRC Press.
8	Gliessman, S.R., & Rosemeyer, M. (2010). *The Conversion to Sustainable Agriculture: Principles, Processes, and Practices.* CRC Press.
9	Harlan, J. R., Gepts, P., Famula, T. R., Bettinger, R. L., Brush, S. B., Damania, A. B., McGuire, P. E., & Qualset, C. O. (Eds.). (2012). *Biodiversity in agriculture: Domestication, evolution, and sustainability.* Cambridge University Press.
10	Jackson, W. (2002). *Natural Systems Agriculture: A Truly Radical Alternative.* Agriculture, Ecosystems & Environment, 88(2), 111–117.
11	Kremen, C., & Miles, A. (2012). *Ecosystem Services in Biologically Diversified versus Conventional Farming Systems.* Ecology and Society, 17(4), 40.
12	Lal, R. (2015). *Restoring Soil Quality to Mitigate Soil Degradation.* Sustainability, 7(5), 5875–5895.
13	Madden, J. P. (2024). *The early years: Historical timeline.* Sustainable Agriculture Research & Education (SARE).
14	Nayar, N. M. (2011). Agrobiodiversity in a biodiversity hotspot: Kerala State, India—its origin and status. *Genetic Resources and Crop Evolution, 58*(1), 55–82. https://doi.org/10.1007/s10722-010-9582-8
15	Odum, E.P. (1971). *Fundamentals of Ecology.* Saunders College Publishing.
16	Paul, A., & Wojtkowski, P. A. (2004). *Landscape agroecology.* Haworth Press.
17	Perfecto, I., Vandermeer, J., & Wright, A. (2009). *Nature's Matrix: Linking Agriculture, Conservation and Food Sovereignty.* Earthscan.
18	Pretty, J. (2008). *Agricultural Sustainability: Concepts, Principles and Evidence.* Philosophical Transactions of the Royal Society B, 363(1491), 447–465.
19	Robertson, G. P., Gross, K. L., Hamilton, S. K., Landis, D. A., Schmidt, T. M., Snapp, S. S., & Swinton, S. M. (2014). Farming for ecosystem services: An ecological approach to production agriculture. *BioScience, 64*(5), 404–415. https://doi.org/10.1093/biosci/biu037
20	Sangeetha, J., Thangadurai, D., & Islam, S. (Eds.). (2020). *Beneficial microbes for sustainable agriculture and environmental management.* CRC Press.
21	Swift, M.J., & Anderson, J.M. (1993). *Biodiversity and Ecosystem Function in Agricultural Systems.* In Schulze & Mooney (Eds.), *Biodiversity and Ecosystem Function.* Springer.
22	Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R., & Polasky, S. (2002). *Agricultural Sustainability and Intensive Production Practices.* Nature, 418, 671–677.
23	Warner, K. D. (2007). *Agroecology in action: Extending alternative agriculture through*

	social networks. MIT Press.
24	Zhang, W., Ricketts, T. H., Kremen, C., Carney, K., & Swinton, S. M. (2007). Ecosystem services and dis-services to agriculture. *Ecological Economics, 64*(2), 253–260. https://doi.org/10.1016/j.ecolecon.2007.02.024

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports on various agroecosystems	5
• Presentations and viva	10

Employability for the Course / Programme

This course enhances the employability in sectors such as agricultural research, environmental consulting, agri-based industries, natural resource management, NGOs, and governmental organizations promoting sustainable development and food security.

23	ETHNOBOTANY		KU6DSEPLS316
0DSE	Semester: 6	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Recognize the cultural and ecological significance of traditional plant use.
CO2	Ability to identify key ethnobotanical practices and their relevance in modern society.

CO3	Understanding the value and process of documentation methods for indigenous knowledge.
CO4	Assess case studies of successful ABS implementation in India and globally.
CO5	Students will develop ethical perspectives for sustainable utilization of biological resources.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This undergraduate course explores the intricate relationships between people and plants, emphasizing the ethnobotanical heritage of India with an emphasis to Kerala.

- *First module introduces the foundation of ethnobotany, its evolution, and its role in bridging cultural knowledge and modern science.*
- *Second module explores traditional plant use in India with a special emphasis on Kerala's indigenous cultures and ecosystems.*
- *Third module focuses on the applied dimensions of ethnobotany in medicine, food, and industry, and its role in sustainable development.*
- *Fourth module discusses policy frameworks and success stories in Access and Benefit Sharing (ABS) for equitable and sustainable use of traditional resources.*

This course will provide opportunities to think and act on various contemporary approaches of biocultural conservation and benefit sharing.

Course Objectives:

1. To understand the origin, scope, and interdisciplinary nature of ethnobotany.
2. To document and interpret traditional plant knowledge systems in India and Kerala.
3. To analyze ethnomedicinal practices and socio-cultural dimensions of plant use among tribal communities.
4. To evaluate Access and Benefit Sharing (ABS) mechanisms and biocultural rights in sustainable resource management.
5. To foster awareness on the integration of traditional ecological knowledge in modern conservation strategies.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Introduction to Ethnobotany 13 hrs 1.1.Definition, history, and scope of ethnobotany — the interface between plants and people. local and global food systems, cultural and social aspects of food. 1.2.Methods in ethnobotanical research: field surveys, participatory rural appraisal (PRA), herbarium techniques, and digital documentation. traditional knowledge protection trhough Traditional Knowledge Digital Library Unit (TKDL). Traditional Ecological Knowledge Mapping (TEK). 1.3.Ethnobotany as an interdisciplinary science Role of ethnobotany in taxonomy, pharmacognosy, and conservation biology. Role of ethnobotany in art, craft, ecology, conservation and sustainable development. 1.4.Global perspectives in ethnobotany: contributions from India and worldwide pioneers (J.W. Harshberger, E.K. Schultes, S.K.Jain)
Module 2: Ethnobotany in India and Kerala 13 Hours 2.1.Ethnobotanical diversity in India: A brief account of the tribes of India. Regional variations and cultural heritage. 2.2. Major tribal groups of Kerala (Irulas, Adiyan, Koraga, Kurichiyas, Kani, Cholanaikan, Kadar, Kurumba, Kuruman, Paniyas, Ulladan). 2.3. Plant-based livelihood, healing practices, and rituals: Wild food plants, intoxicants, beverages, resins, oils and dyes. plants and plant products used in rituals, ceremonies and magico-religious beliefs 2.4. traditional ecological knowledge in agriculture and Conservation; indigenous farming systems. Sacred groves (Kavus) and biocultural landscapes of Kerala as models of in situ conservation.
Module 3: Applied and Medicinal Ethnobotany 12 Hours 3.1.Ethnomedicine: traditional healers, ethnopharmacology, and validation of herbal remedies. Ethnomedicobotany and ethnopharmacology Ethnomedicine systems: Ayurveda, home remedies, and folk medicine. reverse pharmacology 3.2.Ethnobotany of food plants, spices, dyes, fibers, and aromatic species. 3.3.Bioprospecting: Types of bioprospecting: Chemical prospecting; Gene prospecting; bionic prospecting. Bioprospecting and conservation. Regulations of bioprospecting. Bioprospecting and sustainable development. . 3.4. Community-based resource management: AICRPE-All India Coordinated Research Project on Ethno biology, FRLHT- Foundation for the Revitalisation of Local Health Traditions.
Module 4: ABS and Conservation of Ethnobotanical Heritage 10 Hours 4.1.Biological Diversity Act (2002), Nagoya Protocol, and institutional frameworks for ABS. 4.2. ABS and biopiracy. Concepts of ABS and Biopiracy. Case studies of successful ABS models: Kani Tribe & Jeevani (Kerala), Hoodia (South Africa), and Indian biodiversity initiatives. 4.3.Role of Biodiversity Management Committees (BMCs) and People's Biodiversity Registers (PBRs). 4.4.Future prospects: integrating traditional ecological knowledge with modern biotechnological and conservation strategies.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 4Hrs** Contributions of E.K.Janakiammal, K.S.Manilal, V.V Sivarajan & P. Pushpangadan.

Biodiversity conservation by indigenous groups; role of ethnic groups in conservation of plant genetic resources **Practicals 8Hrs** 1. Conduct a field visit to a major sacred grove of the nearby area and submit a report on its floristic diversity and ecology. 2. Prepare voucher specimens of at least 10 wild plants of ethnobotanic interest. 3. Conduct a field survey to record ethnobotanical/traditional knowledge from the nearby ethnic population, and submit the report.

Suggested Assignment Topics- Theory

1. Major ethnomedicines of Kerala and their uses
2. Tribes of North Kerala
3. Medcines used in Kalrippayattu
4. Theyyam and dye yielding plants

Suggested Assignment Topics- Practical

1. Survey on plants used by Northern Kerala- in Kalarippayattu, Theyyam
2. Folk medcines used in Balachikilsa, vishachikilsa and Nethra chikilsa
3. Folkmedicines used for burns

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Balick, M. J., & Cox, P. A. (1996). Plants, people, and culture: The science of ethnobotany. Scientific American Library.
2	Cotton, C. M. (1996). Ethnobotany: Principles and applications. John Wiley & Sons.
3	Cunningham, A. B. (2001). Applied ethnobotany: People, wild plant use, and conservation. Earthscan.
4	Gadgil, M., & Berkes, F. (1991). Traditional resource management systems. Resource Management and Optimization, 18(3–4), 127–141.
5	Hamilton, A. C. (2004). Medicinal plants, conservation and livelihoods. Biodiversity and Conservation, 13(8), 1477–1517.
6	Jain, S. K. (1995). A manual of ethnobotany (2nd ed.). Scientific Publishers.
7	Kumar, B. M., & Nair, P. K. R. (2004). The enigma of tropical homegardens. Agroforestry Systems, 61(1–3), 135–152.
8	Martin, G. J. (2004). Ethnobotany: A methods manual. Earthscan.
9	Nayar, N. M. (2011). Agrobiodiversity in a biodiversity hotspot: Kerala State, India—its origin and status. Genetic Resources and Crop Evolution, 58(1), 55–82.
10	Pandey, A. K., & Tripathi, N. N. (2017). Ethnobotany and medicinal plants of India and Nepal. Scientific Publishers.
11	Pei, S., & Huai, H. (2007). Ethnobotany and modernization of traditional Chinese medicine. Ethnobotany Research & Applications, 5, 147–153.
12	Pushpangadan, P., & Rajasekharan, S. (2012). Ethnobiology and traditional medicine of India. NISCAIR-CSIR.
13	Rama Rao, N., & Henry, A. N. (1996). *The ethnobotany of Eastern Ghats in Andhra Pradesh, India.* Botanical Survey of India.
14	Shashi, S. S. (2004). *Tribes of Kerala.* Anmol Publications Pvt. Ltd.
15	Singh, K. K., & Kumar, K. (2018). Ethnobotany and medicinal plants of India and Nepal, Vol. 2. Scientific Publishers.
16	Sinha, R. K. (1996). *Ethnobotany: The renaissance of traditional herbal medicine.* INA–Shree Publishers.
17	Swiderska, K., Argumedo, A., Song, Y., Li, J., Pant, R., & Herrera, H. (2011). The role of traditional knowledge and Access and Benefit Sharing in climate adaptation. IIED Report.

18	Venkataraman, K., & Faizi, S. (2019). Success stories in Access and Benefit Sharing from India. Current Science, 117(10), 1583–1589.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports on local medicinal plants	5
• Presentations and viva voce	10

Employability for the Course / Programme

The course enhances students' prospects in careers related to ethnobotanical research, biodiversity conservation, herbal industries, natural product development, policy analysis, and community-based resource management, fostering skills valuable for NGOs, research institutions, and governmental biodiversity programs.

24	**Pharmacognosy and Phytochemistry**		**KU6DSEPLS317**
DSE	**Semester: 6**	**Hrs/week: 4 Theory**	**Credits: 4**

Course Pre-requisite:

1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Comprehend the fundamental concepts and classifications in pharmacognosy.
CO2	Identify biological sources and uses of primary and secondary metabolites.
CO3	Apply analytical and chromatographic techniques for drug characterization.
CO4	Relate pharmacognostic knowledge to diverse traditional medical systems.

CO5	Evaluate quality assurance protocols and WHO guidelines for herbal drugs.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This undergraduate course provides an integrated understanding of drugs of natural origin—their sources, constituents, extraction methods, evaluation, and roles in traditional and modern medicine.

- *First module introduces the history, scope, sources, and classification of drugs of natural origin, forming the base for pharmacognostic studies.*
- *Second module focuses on biological sources, chemistry, and pharmaceutical importance of primary and secondary plant metabolites and related products.*
- *Third module emphasizes modern extraction and analytical tools used in isolating, identifying, and evaluating drugs of natural origin.*
- *Fourth module integrates pharmacognosy with diverse medical systems and emphasizes WHO guidelines for standardization and safety of herbal drugs.*

This course will help the student to become more enthusiastic towards the medicinal value of plants.

Course Objectives:

1. To understand the origin, scope, and significance of pharmacognosy in the development of natural drugs.
2. To study various natural sources of drugs and their classification.
3. To learn about metabolites, their chemistry, sources, preparation, and pharmaceutical uses.
4. To understand methods for evaluating and ensuring the quality and purity of crude drugs.
5. To gain knowledge of extraction, characterization, and principles of major systems of medicine.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Foundations and Sources of Pharmacognosy	**12 Hours**
1.1. Definition, history, and development of pharmacognosy.	

1.2. Sources of natural drugs: plant, animal, marine, and tissue culture origins. 1.3. Classification of crude drugs: alphabetical, morphological, taxonomical, chemical, and pharmacological systems. 1.3. Organized and unorganized drugs: dried latex, juices, extracts, gums, mucilages, oleoresins, and oleo-gum-resins.
Module 2: Natural Products and Metabolites 12 Hours 2.1. Primary metabolites: carbohydrates (acacia, agar, honey), proteins and enzymes (gelatin, papain, pepsin, serratiopeptidase), lipids (castor oil, beeswax, wool fat). 2.2. Secondary metabolites: alkaloids, glycosides, flavonoids, tannins, volatile oils, and resins – classification and identification tests. 2.3. Plant products and fibers: cotton, jute, hemp; hallucinogens, teratogens, and natural allergens. 2.4. Marine drugs and bioactive agents from oceanic sources
Module 3: Extraction, Characterization, and Evaluation Techniques 12 Hours 3.1. Extraction methods: cold maceration, percolation, Soxhlet, Clevenger apparatus. 3.2. Chromatographic techniques: TLC, paper chromatography, column chromatography. 3.3. Instrumental methods: HPLC, GC, GC-MS, LC-MS in drug characterization. 3.4. Evaluation of natural drugs: organoleptic, microscopic, physical, chemical, and biological methods; adulteration detection
Module 4: Systems of Medicine and Quality Assurance 12 Hours 4.1. Principles of major systems of medicine: Allopathic, Ayurveda, Unani, Siddha, Homeopathy, and Chinese systems. 4.2. WHO guidelines for herbal drug standardization and quality control. 4.3. Good Agricultural and Collection Practices (GACP) and Good Manufacturing Practices (GMP) for herbal products. 4.4. Adulteration control, toxicological evaluation, and safety assessment of natural drugs.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 4Hrs** Adulteration in medicinal plants. Medicines from plants – successful stories from Kerala. **Practicals 8Hrs** 1.Documentaion of medicinal plants 2. Internship in a pharmaceutical industry 3. visit to well equipped phytochemical lab.

Suggested Assignment Topics- Theory

1. Folk medicines and single remedies
2. Major medicinal plants of our premises
3. Phytochemistry of medicinal plants

Suggested Assignment Topics- Practical

1. Visit to quality testing labs
2. Collection of reports on drug adulteration
3. Anatomical study of medicinal plants .

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Ali, M. (2012). *Pharmacognosy and phytochemistry.* CBS Publishers.

2	Chatwal, G. R., & Anand, S. K. (2011). *Instrumental methods of chemical analysis.* Himalaya Publishing House.
3	Cordell, G. A. (2017). *Natural products drug discovery in the 21st century.* Academic Press.
4	Cox, P. A., & Balick, M. J. (1994). The ethnobotanical approach to drug discovery. *Scientific American, 270*(6), 82–87.
5	Daniel, M. (2006). *Medicinal plants: Chemistry and properties.* Science Publishers.
6	Evans, W. C. (2009). *Trease and Evans pharmacognosy* (16th ed.). Saunders Elsevier.
7	Farnsworth, N. R. (1990). The role of ethnopharmacology in drug development. *Bioactive Compounds from Plants, Ciba Foundation Symposium, 154*, 2–21.
8	Harborne, J. B. (1998). *Phytochemical methods: A guide to modern techniques of plant analysis.* Chapman & Hall.
9	Heinrich, M., Barnes, J., Gibbons, S., & Williamson, E. (2012). *Fundamentals of pharmacognosy and phytotherapy* (2nd ed.). Churchill Livingstone.
10	Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2015). *Pharmacognosy* (50th ed.). Nirali Prakashan.
11	Krishnamurthy, K. V. (2010). *Methods in cell wall cytochemistry.* CRC Press.
12	Khandelwal, K. R. (2015). *Practical pharmacognosy: Techniques and experiments.* Nirali Prakashan.
13	Mukherjee, P. K. (2002). *Quality control of herbal drugs: An approach to evaluation of botanicals.* Business Horizons.
14	Ncube, B., Finnie, J. F., & Van Staden, J. (2012). Quality control of herbal medicines. *South African Journal of Botany, 82*, 101–107.
15	Pandey, B. P. (2010). *Pharmacognosy.* S. Chand Publishing.
16	Rama Rao, N., & Henry, A. N. (1996). *The ethnobotany of Eastern Ghats in Andhra Pradesh, India.* Botanical Survey of India.
17	Sarker, S. D., Latif, Z., & Gray, A. I. (2006). *Natural products isolation* (2nd ed.). Springer.
18	Shashi, S. S. (2004). *Tribes of Kerala.* Anmol Publications Pvt. Ltd.
19	Sethi, P. D. (1996). *High performance thin layer chromatography (HPTLC): Quantitative analysis of pharmaceutical formulations.* CBS Publishers.
20	Sinha, R. K. (1996). *Ethnobotany: The renaissance of traditional herbal medicine.* INA–Shree Publishers.
21	Sofowora, A. (1993). *Medicinal plants and traditional medicine in Africa.* Spectrum Books Ltd.
22	Tyler, V. E., Brady, L. R., & Robbers, J. E. (1988). *Pharmacognosy.* Lea & Febiger.
23	Wagner, H., & Bladt, S. (2009). *Plant drug analysis: A thin layer chromatography atlas.* Springer.
24	WHO. (2000). *General guidelines for methodologies on research and evaluation of traditional medicine.* World Health Organization.
25	WHO. (2003). *Guidelines on good agricultural and collection practices (GACP) for medicinal plants.* World Health Organization.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Visit to labs	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	70
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports on drugs	5
• Presentations and viva voce	10

Employability for the Course / Programme

This course develops skills in natural product research, herbal drug formulation, quality control, and phytochemical analysis, preparing students for employment in pharmaceutical industries, research laboratories, herbal product manufacturing, regulatory agencies, and academia.

25	Internship		KU6INTPLS318
INT	Semester: 6	Hrs/week:	Credits: 2

Course Pre-requisite:
1. Knowledge in Biology at 201-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Gets hands-on experience in areas such as plant identification, taxonomy, ecology, plant physiology, and laboratory techniques.
CO2	Students learn to collect samples, record observations, analyse data, and prepare scientific reports or presentations.
CO3	Students familiarize with the functioning of research laboratories, botanical gardens, agricultural institutions, environmental agencies, or biotech companies.

CO4	Develop skills in microscopy, field survey methods, documentation, teamwork, and scientific communication.
CO5	The internship helps students understand career opportunities in botany-related fields such as research, conservation, agriculture, forestry, biotechnology, and environmental management.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1												
CO2												
CO3												
CO4								√	√	√	√	
CO5									√	√	√	√

Course Objectives:

1. To engage with practical aspects of botany and allied branches.
2. To increase the learning of botany more meaningful
3. To enhance the employability.

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
0	2	2	0+ 0+ 4 (0+ 0 + 15)	4	15	35	50

COURSE CONTENT

Each student must complete an internship within the six semesters to engage with practical aspects of their learning and enhance employability. **A report** is required **by the end of the sixth semester.** The internship must last a ***minimum of 60 working hours*** and can be **on-campus or off-campus**, potentially ***consisting of 1-3 accumulated*** activities.

Off-campus internships require prior approval, and an attendance certificate must be submitted to the HoD upon rejoining. HoDs ensure completion of the internship.

Suggested Internships: Summer internships at biology institutes or local industries related to botany/ecology/agriculture, field trips to various ecosystems or nature camps, apprenticeships in NGOs or relevant industries, and social responsibility activities such as river restoration, PBR preparation, landscaping, and green auditing.

Student Responsibilities: Selecting the internship topic/activity, discussing with a mentor, planning and execution, and preparing and presenting the report.

Teacher/Supervising Guide Responsibilities: Confirming the topic/activity, providing guidance, and correcting and certifying the prepared report.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments	➢ ICT powerpoint presentation

➢ Collaborative learning-Group discussion ➢ Supervision by the supervising teacher/faculty ➢ Survey and discussions on the topic of internship	➢ Report on internship ➢ Practical sessions with demonstrations and hands on experiences ➢ Viva Voce

INTERNSHIP EVALUATION

The components of internship evaluation in include performance evaluation, attendance and participation, the quality of the internship report, and the effectiveness of the presentation. Additional components are the viva voce examination, feedback from the internship site, self-assessment, and, if applicable, peer assessment. Continuous Comprehensive Assessment (CCA) will be conducted by the faculty in charge, while the End Semester Examination will be evaluated by the Department Council, excluding the faculty in charge.

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE (70%)	
• University Examination- Report preparation, presentation and Viva voce	35
Continuous Comprehensive Assessment CCA (30%)	
• Report	5
• Viva	5
• Presentations	5

Employability for the Course / Programme

The interest in choosing the internship programme is reflecting the attitude of the student towards job and research in botany/plant science /life science.

26	Advanced course in Plant Developmental Biology		KU7DSCPLS401
DSC	Semester: 7	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 301-399 level
2. Ability to write examination in English

Course Outcomes	
CO1	Demonstrate in-depth knowledge of key developmental processes in angiosperms, including gametophyte formation, embryo patterning, seed/fruit maturation and reproductive alternatives (apomixis, polyembryony).
CO2	Be able to integrate molecular, hormonal, epigenetic and cellular regulatory mechanisms with developmental phenomena in plants.
CO3	Show competence in understanding evolutionary and comparative developmental frameworks and how they relate to morphological and reproductive diversity in plants.

CO4	Be capable of analysing how environmental, temporal and physiological signals (light, circadian clock, stress, regeneration) regulate plant developmental outcomes.
CO5	Be prepared to engage in research or applied work (breeding, biotechnology, crop improvement) by linking developmental biology with practical plant science applications.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course provides an integrative and advanced study of plant developmental biology.
• *First module is dealing with the developmental processes of angiosperms from gametogenesis through fertilization, embryo and endosperm formation, seed and fruit development, and the special cases of apomixis and polyembryony.* • *Second module delves into the cellular and molecular control of plant development* • *Third module examines how developmental genetics, gene regulatory networks, genome evolution and evolutionary developmental (Evo-Devo) approaches shape plant form and development across angiosperms.* • *The final module deals with how environmental cues, light, circadian rhythms, stress and regeneration integrate with developmental programs to control plant growth, form and developmental transitions.*
This course will provide opportunities to comprehend the molecular events and its regulation which is the foundation of plants and its developments.

Course Objectives:

1. Explain the molecular and genetic mechanisms underlying gametogenesis, double fertilization, embryogenesis, endosperm formation, seed and fruit development in angiosperms.
2. Describe the roles of meristematic stem-cell niches, hormonal signalling networks, epigenetic and cell-to-cell communication mechanisms in plant development.
3. Critically evaluate the evolutionary and developmental (Evo-Devo) processes and genome-level events (e.g., gene duplication, polyploidy) that have shaped plant morphology and reproduction.
4. Analyse how physiological and temporal regulatory systems (such as photomorphogenesis, circadian rhythms, stress responses and regeneration/totipotency) influence plant developmental pathways.
5. Apply current developmental, molecular and biotechnological concepts (e.g., hormone regulation, gene editing, apomixis, somatic embryogenesis) in the context of plant breeding, crop improvement or research.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Angiosperm Embryology and Reproductive Development 12 hrs

1.1.Gametogenesis and Double Fertilization**:** Molecular and genetic control of gametophyte development and signaling between male and female gametophytes. Mechanisms of double fertilization—sperm–egg and sperm–central cell interactions, signaling pathways, and fusion events. Regulation by transcription factors and hormones during gamete formation and fertilization.

1.2. Embryo Development: Zygotic embryogenesis, pattern formation, and polarity establishment; morphogen gradients and developmental stages—proembryo, globular, heart-shaped, torpedo, and mature embryo. Apical–basal and radial patterning; roles of auxin gradients and transcription factors (WOX, LEC, FUS) in embryo patterning and polarity.

1.3. Seed and Fruit Development: Genetic, hormonal, and epigenetic regulation of seed maturation, desiccation tolerance, dormancy, and germination. Coordination of ABA and GA signaling; transcription factors (LEC, FUS, ABI) in seed development. Fruit morphogenesis and hormonal crosstalk (auxin–ethylene–cytokinin) during fruit set and ripening.

1.4. Apomixis and Polyembryony: Asexual seed formation—mechanisms of diplospory, apospory, and adventitious embryony. Molecular basis of apomixis, bypassing meiosis and fertilization; genetic and epigenetic regulation. Evolutionary significance and biotechnological applications in clonal propagation and hybrid seed production.

Module 2: Cellular and Molecular Regulation of Plant Development 12 hrs

2.1 Stem Cell Niches and Meristem Function: Shoot and root apical meristem organization; stem cell maintenance and organogenesis. SAM/RAM activity, lateral organ initiation, and regulation through WUS–CLV feedback loops and KNOX gene networks. Genetic and hormonal control of meristem identity and differentiation.

2.2.Hormonal Crosstalk and Signal Integration: Auxin, cytokinin, gibberellin, ethylene, and abscisic acid biosynthesis, signaling, and transport. Role of PIN proteins, ARFs, and DELLA proteins in signaling cascades and feedback regulation. Hormonal crosstalk and integration in organ initiation, patterning, and phase transitions

2. 3. Epigenetic Regulation in Development: DNA methylation, histone modification, chromatin remodeling, and small RNA pathways (miRNA, siRNA) in developmental control. Role of Polycomb-group proteins, imprinting, and epigenetic memory in phase transitions and developmental plasticity.

2.4.Cell-to-Cell Communication and Polarity: Plasmodesmata-mediated transport, peptide signaling, and intercellular communication in development. Establishment of auxin gradients, symplastic transport, and positional information for polarity and organ patterning

Module 3: Genetic, Evolutionary, and Evo-Devo Perspectives 12 hrs

3.1. Developmental Genetics and Model Systems: Genetic regulation of development using *Arabidopsis thaliana*, *Oryza sativa*, and *Medicago*. Forward and reverse genetics, mutant analysis, and CRISPR-based gene editing.

3.2. Molecular Basis of Evolutionary Innovations: Evolution of flowers, fruits, and seed structures; role of gene duplication, diversification, and regulatory rewiring. MADS-box gene function in organ identity and developmental innovations.

3.3. Comparative Development and Evo-Devo: Comparative embryology and gene expression analyses linking genotype to phenotype. Evolutionary developmental biology perspectives on serial homology and morphological evolution. 3.4. Genome Evolution and Developmental Plasticity: Epigenetic and environmental regulation of developmental plasticity. Gene dosage effects, epialleles, and modularity in evolutionary adaptation.
Module 4. Physiological and Temporal Control of Development 12 hrs 4.1. Photomorphogenesis and Light-Regulated Development: Light perception and photoreceptor signaling (phytochromes, cryptochromes, phototropins). Photomorphogenic responses—etiolation, de-etiolation, shade avoidance, and flowering induction. Integration of light, hormonal, and genetic pathways via COP1 and HY5 regulation. 4.2. Biorhythms and Circadian Regulation: Circadian clock components and gene regulatory circuits (TOC1, CCA1, LHY). Oscillations in gene expression controlling growth, hormone production, and flowering. Temporal coordination of physiology, metabolism, and developmental transitions. .4.3. Environmental and Stress-Induced Development: Developmental plasticity under abiotic and biotic stresses. Stress perception and signal transduction pathways integrating ROS, ABA, and transcriptional networks. Cross-talk between stress and developmental pathways in adaptive morphogenesis. 4.4. Regeneration and Totipotency: Molecular basis of totipotency and its applications in plant tissue culture and biotechnology.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 12 Hrs** Basics in development of plants: Basic morphological, anatomical biochemical changes involved in root stem, leaf and flower development. Structure and development pattern in microsporangium and megasporangium, double fertilisation and triple fusion; post fertilisation changes and endosperm development. Fruit and seed development: morphological, anatomical and biochemical changes. Regeneration and Totipotency: Molecular basis of totipotency and its applications in plant tissue culture and biotechnology.

Suggested Assignment Topics- Theory

1. Leaf development
2. Stem development from plumule
3. Laf development
4. Flower developments and factors affecting
5. Root and pneumatophore development

Suggested Assignment Topics- Practical

1. Embryo rescue technique
2. Callus culture
3. Anther culture
4. Application of hormones for flowering, fruit retention and development, etc.

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Chen, X.-Y., & Kim, J.-Y. (2006). Transport of macromolecules through plasmodesmata and the phloem. Physiologia Plantarum, 126(4), 560-571. https://doi.org/10.1111/j.1399-3054.2006.00630.x

2	Dresselhaus, T., & Jürgens, G. (2021). Comparative embryogenesis in angiosperms: Activation and patterning of embryonic cell lineages. Annual Review of Plant Biology, 72, 641–676. https://doi.org/10.1146/annurev-arplant-082520-094112
3	Evans, M. M. S., & Barton, M. K. (1997). Genetics of angiosperm shoot apical meristem development. Annual Review of Plant Biology, 48, 673–701. https://doi.org/10.1146/annurev.arplant.48.1.673
4	Hake, S., Smith, H. M., Holtan, H., Magnani, E., Mele, G., & Ramirez, J. (2004). The role of KNOX genes in plant development. Annual Review of Cell and Developmental Biology, 20, 125-151.
5	Hojsgaard, D. (Ed.). (2021). Molecular basis of apomixis in plants. MDPI Books. https://doi.org/10.3390/books978-3-0365-1507-6
6	Hudson, M. E., & Quail, P. H. (2011). Rapid, organ-specific transcriptional responses to light regulate photomorphogenic development in dicot seedlings. Plant Physiology, 156(4), 2124-2140. https://doi.org/10.1104/pp.111.179416
7	Laurie, J. D. (2013). Epigenetic regulation of repetitive DNA through mitotic asynchrony following double fertilization in angiosperms. arXiv preprint.
8	Niu, Y., Figueroa, P., & Browse, J. (2011). Light promotes jasmonate biosynthesis to regulate photomorphogenesis in Arabidopsis. Journal of Experimental Botany, 62(6), 2143–2154. https://doi.org/10.1093/jxb/erq408
9	Specht, C. D., & Bartlett, M. E. (2009). Flower evolution: The origin and subsequent diversification of the angiosperm flower. Annual Review of Ecology, Evolution, and Systematics, 40, 217–243. https://doi.org/10.1146/annurev.ecolsys.110308.120203
10	von Arnim, A., & Deng, X.-W. (1996). Light control of seedling development. Annual Review of Plant Biology, 47, 215–243. https://doi.org/10.1146/annurev.arplant.47.1.215
11	Acquaah, G. (2012). Principles of Plant Genetics and Breeding (2nd ed.). Wiley-Blackwell.
12	Barresi, M., & Gilbert, S. F. (2020). Developmental Biology (12th ed.). Oxford University Press.
13	Beck, C. B. (2005). An Introduction to Plant Structure and Development. Cambridge University Press.
14	Bhatla, S. C., & Lal, M. A. (2023). Plant Physiology, Development and Metabolism (2nd ed.). Springer Singapore.
15	Cronk, Q. C. B., Bateman, R. M., & Hawkins, J. A. (Eds.). (2002). Developmental Genetics and Plant Evolution. CRC Press.
16	Dashek, W. V., & Harrison, M. (2006). Plant Cell Biology. CRC Press.
17	Evert, R. F., & Eichhorn, S. E. (2012). Raven Biology of Plants (8th ed.). W. H. Freeman.
18	Gresshoff, P. M. (1992). Plant Biotechnology and Development. CRC Press.
19	Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to Plant Physiology (4th ed.). Wiley-John Wiley & Sons.
20	Krishnamurthy, K. V. (2015). Plant Biology and Biotechnology: Volume I – Plant Diversity, Organization, Function and Improvement. Springer New Delhi.
21	Krishnamurthy, K. V., & Raman, A. (2015). Growth and Development in Plants (21st Century Biology and Agriculture: Textbook Series). Scientific Publishers.
22	Leopold, A. C., & Kriedemann, P. E. (1975). Plant Growth and Development. Springer.
23	Mauseth, J. D. (2014). Botany: An Introduction to Plant Biology (6th ed.). Jones & Bartlett Learning.
24	Pua, E. C., & Davey, M. R. (Eds.). (2010). Plant Developmental Biology – Biotechnological Perspectives: Volume 1. Springer Berlin Heidelberg.
25	Pua, E. C., & Davey, M. R. (Eds.). (2010). Plant Developmental Biology – Biotechnological Perspectives: Volume 2. Springer Berlin Heidelberg.
26	Raghavan, V. (2000). Developmental Biology of Flowering Plants. Springer New York.
27	Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2005). Biology of Plants (7th ed.). W. H. Freeman.

28	Simpson, M. G. (2010). Plant Systematics (2nd ed.). Elsevier Academic Press.
29	Smith, G. M. (1955). Botany: An Introduction to Plant Biology (4th ed.). McGraw-Hill.
30	Taiz, L., Møller, I. M., Murphy, A., & Zeiger, E. (2022). Plant Physiology and Development (7th ed.).

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	10
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

Graduates can pursue careers in plant research, environmental consultancy, biotechnology, forestry, ecological conservation, and teaching.

27	Advanced course in Cryptogamic Diversity		KU7DSCPLS402
DSC	Semester: 7	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 301-399 level
2. Ability to write examination in English

Course Outcomes	
CO1	Students acquire detailed knowledge of algae, fungi, lichens, bryophytes, and pteridophytes, including their classification and characteristics.
CO2	Students learn to identify different cryptogamic species using morphological, anatomical, and reproductive features.
CO3	Understand the life cycles, evolutionary relationships, and ecological significance of cryptogams.
CO4	Students gain practical experience in specimen collection, preservation, microscopic observation, and preparation of herbarium samples.

CO5	Understand the role of cryptogams in soil formation, biofertilizers, medicine, food, environmental indicators, and ecosystem balance.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course provides an integrated understanding of the diversity, reproduction, evolution, and applied aspects of algae, bryophytes, and pteridophytes.
• *First module is dealing with taxonomy, phylogeny, and molecular trends in algae, exploring the evolutionary relationships among major algal groups.* • *Next module focuses on bryophyte classification, diversity, reproductive biology, and ecological importance.* • *Third module examines pteridophyte diversity, classification, and evolutionary trends.* • *Last module emphasizes practical techniques for studying algae, bryophytes, and pteridophytes, including collection, preservation, culturing, spore studies, and molecular phylogeny with DNA barcoding.*
This course will provide opportunities to,study the anatomical and morphological features of algae to pteridophytes.

Course Objectives:

1. Understand the taxonomy, phylogeny, and molecular trends in algae, bryophytes, and pteridophytes.
2. Examine evolutionary theories and hypotheses regarding the origin of higher plants from algae.
3. Study reproductive biology and life cycles of lower and vascular plants.
4. Gain practical skills in spore studies, culturing, and DNA-based phylogenetic analysis.
5. Assess ecological, economic, and biotechnological applications of algae, bryophytes, and pteridophytes.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	35 (25T+ 10P)	65 (50T + 15P)	100

COURSE CONTENT

Module 1: Diversity, Reproduction, and Evolution of algae 10 hrs
1.1 Taxonomy, Phylogeny, and Molecular Trends: van den Hoek et al. (1995), Lee (2008). Modern trends. Fossil Algae

1.2. Salient features of Algal groups: Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta, Euglenophyta, Dinophyta, Chrysophyta and Cryptophyta. Molecular phylogeny and evolutionary relationships among major algal groups. 1.3. Evolutionary Theories and hypotheses: revisions of Endosymbiotic theory – primary and secondary. Origin of higher plant groups from algae- Charophycean hypothesis. Co evolutionary hypothesis. Stepwise terrestrialisation theory. 1.4. Applications, Ecology, and Algal Toxicology: Role in primary productivity, carbon sequestration, and nitrogen fixation. Biofouling, biofuel, bioluminescence, and toxicity syndromes (NSP, DSP, ASP, PSP, CFP and cyanobacterial toxins). Algae as live feed in fisheries.
Module 2: Diversity, Reproduction, and Evolution of Bryophytes 10 hrs 2.1. General Features and Classification: General features of Bryophytes. Comparison of Rothmaler (1951) and Goffinet et al. (2008).. Fossil bryophytes. 2.2. Diversity of Bryophytes: Salient features upto orders of Hepaticopsida (Jungermanniales, Marchantiales, Pallaviciniales, Aytoniopsidales), Anthocerotopsida (Notothyladales, Anthocerotales), 2.3. Salient features upto orders of Bryopsida (Sphagnales, Polytrichales, Bryales, Funariales, Hypnales). 2.4. Comparison of bryophytes with other groups: similarities and dissimilarities with algae. Algal descent theory on bryophyte origin. Comparative account of bryophytes and pteridophytes.
Module 3: Module 3: Pteridophytes – Classification, Structure, and Evolution 10 hrs 3.1 Classification and Phylogeny: Comparison of classical systems and PPG 2016. DNA barcoding and molecular systematics. Phylogenetic trends within the groups 3.2. Characteristics of living pteridophytes: Lycopodiales, Isoetales, Calamitales, Ophioglossales, Osmundales, Gleicheniales, Salviniales. 3.3. Characteristics of Fossil records: Psilophytales, Lepidodendrales, Calamitales, Primofilicales. 3.4.General topics on pteridophytes. Evolutionary theories: Telome Theory; Polysporangiophyte Theory.
Module 4. Methods for Phycology, bryology and Pteridology. 6 hrs 4.1. Herbarium making of marine macroalgae and sporophytes of ferns. Dry preservation of bryophytes. 4.2. Protocols for microscopic study**:** Whole mount preparation of algal filaments, TTC test for bryophyte spores, FDA staining for viable fern spores, Neutral red for algal cyst germination. 4.3. Culturing: Algal culturing- variations in microalga and macroalga. in-vitro propagation of pteridophytes. 4.4. Molecular Phylogeny and DNA Barcoding for Algae, bryophytes, and pteridophytes. Integration with classical taxonomy and systematics.
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 9 Hrs** Habitat Ecology various cryptogams and their significance. Nutritional variation in algae. Contributions of Indian botanists in cryptogam studies. **Practical 30 Hrs** **1.** Collection, preservation and submission of macro algal herbaria/ bryophytes /ferns/

/whole mounts. (any 5)
2. Collection and study of the algae mentioned below and their identification up to generic level: Pediastrum, Scenedesmus, Hydrodictyon, Ulva, Pithophora, Bulbochaete, Cephaleuros, Draparnaldiopsis, Bryopsis, Codium, Caulerpa, Halimeda. Closterium, Nitella, Botrydium, Biddulphia, Coscinodiscus, Ectocarpus, Dictyota, Padina, Turbinaria. Batrachospermum, Gracilaria and Champia. (any 10 from the list)
3. Morphological and reproductive study of following bryophytes using cleared whole mount preparations. dissections and sections: Pallavicinia. Cyathodium. Lunularia, Targionia. Porella, Sphagnum, Bryum, Fissidens. (any 5 from the list)
4. Comparative study of vegetative and reproductive structures of the living pteridophyte genera mentioned below- Lycopodium, Gleichenia, Blechnum, Angiopteris, Salvinia, Ceratopteris, Asplenium, Acrostichum Azolla and Salvinia. (any 5 from the list)
5. Fossil Pteridophytes Rhynia, Lepidodendron, Calamites, Sphenophyllum. (any two from the list)

Suggested Assignment Topics- Theory
1. Beneficial harmful effects of cryptogams
2. Weeds among cryptogams
3. Diversity in plant body in algae, bryophytes and pteridophytes
4. Medicinal and religious uses of cryptogams

Suggested Assignment Topics- Practical
1. Field visits
2. Examination of Azolla to find out the algal association
3. Collection and preservation of cryptogams
4. Photo documentation of cryptogams

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bhattacharya, D. (2005). Origin and evolution of algae: Endosymbiotic theory revisited. *Plant Biology, 7*, 219–227.
2	Bhattacharya, D., & Medlin, L. (1998). Algal phylogeny and the origin of land plants. *Trends in Ecology & Evolution, 13*(11), 470–475.
3	Bold, H. C., & Wynne, M. J. (1985). *Introduction to the Algae: Structure and Reproduction*. Prentice-Hall.
4	Bower, F. O. (1923). *The Ferns: Morphology, Systematics, and Distribution*. Cambridge University Press.
5	Delwiche, C. F., & Cooper, E. D. (2015). The evolutionary origin of plants. *American Journal of Botany, 102*(12), 1925–1939.
6	Fritsch, F. E. (1935). *The Structure and Reproduction of Algae* (Vols. 1–2). Cambridge University Press.
7	Gensel, P. G., & Edwards, D. (2001). Plants on land: The origin and diversification of vascular plants. *Science, 293*, 1467–1470.
8	Goffinet, B., & Shaw, A. J. (2009). *Bryophyte Biology* (2nd ed.). Cambridge University Press.
9	Graham, L. E., Graham, J. M., & Wilcox, L. W. (2009). *Algae* (2nd ed.). Pearson Education.
10	Karol, K. G., McCourt, R. M., Cimino, M. T., & Delwiche, C. F. (2001). The closest living relatives of land plants. *Science, 294*(5550), 2351–2353.
11	Kenrick, P., & Crane, P. R. (1997). The origin and early diversification of land plants. *Science, 276*, 262–267.
12	Kenrick, P., & Strullu-Derrien, C. (2014). The origin and early evolution of vascular plants. *New Phytologist, 202*(3), 736–751.
13	Kumar, S., & Tandon, R. N. (2012). *Practical Phycology and Bryology*. Scientific Publishers.

14	Lee, R. E. (2008). *Phycology* (4th ed.). Cambridge University Press.
15	Page, C. N. (2002). *The Evolution of Pteridophytes*. Timber Press.
16	Parihar, N. S. (1972). *Bryophytes: Structure, Reproduction, and Classification*. Central Book Depot.
17	Proctor, M. C. F., & Tuba, Z. (2002). *Desiccation-tolerant Bryophytes: Eco-physiology and Survival*. Springer.
18	Rashid, A. (1998). *An Introduction to Pteridophytes*. Vikas Publishing House.
19	Raven, J. A., & Allen, J. F. (2003). Genomics and algal evolution: Insights into the origin of plants. *Plant Biology, 5*(3), 111–121.
20	Renzaglia, K. S., Duff, R. J., Nickrent, D. L., & Garbary, D. J. (2000). Vegetative and reproductive innovations of early land plants. *International Journal of Plant Sciences, 161*(S6), S349–S372.
21	Rindi, F., & Guiry, M. D. (2004). Molecular approaches to algal taxonomy and phylogeny. *Journal of Phycology, 40*(3), 621–635.
22	Smith, G. M. (1955). *Cryptogamic Botany*. McGraw-Hill.
23	Sporne, K. R. (1962). *The Morphology of Pteridophytes*. Hutchinson & Co.
24	Stewart, W. N., & Rothwell, G. W. (1993). *Paleobotany and the Evolution of Plants*. Cambridge University Press.
25	Van den Hoek, C., Mann, D. G., & Jahns, H. M. (1995). *Algae: An Introduction to Phycology*. Cambridge University Press.
26	Andersen, R.A. (2005). *Algal Culturing Techniques.* Elsevier Academic Press.
27	Stosch, H.A. von (1965). "Observation on resting spore formation in diatoms and dinoflagellates." *Phycologia,* 5, 21–44.
28	Sournia, A. (1978). *Phytoplankton Manual.* UNESCO, Paris.
29	Chopra, R.N., & Kumra, P.K. (1988). *Biology of Bryophytes.* New Age International.
30	Rashid, A. (1998). *An Introduction to Pteridophyta.* Vikas Publishing.
31	Krishnamurthy, K.V. (1988). *Methods in Plant Histochemistry.* Viswanathan Pvt. Ltd.
32	Mishler, B.D. (2001). *Bryophyte Biology.* Cambridge University Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical examination	10

Employability for the Course / Programme

Graduates can pursue careers in plant research, environmental consultancy, biotechnology, forestry, ecological conservation, and teaching.

28	Advanced course in Diversity of Phanerogams		KU7DSCPLS403
DSC	Semester: 7	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 301-399 level
2. Ability to write examination in English

Course Outcomes	
CO1	Identify and describe major gymnosperm and angiosperm groups.
CO2	Explain the evolutionary origin and diversification of flowering plants
CO3	Apply taxonomic methods for plant collection, preservation, and classification.
CO4	Interpret phylogenetic data and construct basic evolutionary trees.
CO5	Communicate scientific descriptions and use diagnostic keys effectively for plant identification.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This advance course provides an integrated understanding of the diversity, evolution, and classification of phanerogams.
• *First module introduces the diversity, morphology, and evolutionary relationships of gymnosperms, from extinct seed ferns to living conifers and cycads.* • *Second module focuses on the origin and diversification of flowering plants, tracing the morphological evolution of reproductive organs and major evolutionary theories.* • *Third module provides a foundation in classical and modern plant taxonomy.* • *Last module trains students in technical description and identification of angiosperm families*
This course will provide you opportunities to explore major evolutionary transitions, coevolutionary interactions, and modern taxonomic methods that connect classical botany with molecular systematics.

Course Objectives:

1. To understand the diversity, structure, and evolutionary relationships of gymnosperms and angiosperms.
2. To study the morphological and phylogenetic evolution of flowering plants.
3. To develop proficiency in plant identification, herbarium preparation, and classification.
4. To apply modern taxonomic principles, including ICN and molecular tools.
5. To recognize coevolutionary processes shaping plant–pollinator interactions.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	35 (25T+ 10P)	65 (50T + 15P)	100

COURSE CONTENT

Module 1: Gymnosperms – Diversity, Morphology, and Phylogeny (12 hrs)

1.1. General Characters and Evolutionary Trends: Comparison with other plant groups. Phylogenomics and modern classification (Christenhusz et al., 2011).

1.2. Diversity of Gymnosperm Orders: Salient features of Pteridospermales, Pentoxylales, Bennettitales, Cycadales, Coniferales, Ginkgoales, Taxales, Gnetales. Interrelatiship among groups.

1.3. Evolutionary trends and Phylogenetic Relationships: Evolutionary trends and interrelationships among orders 1.4. Indian Gymnosperm studies and Economic importance: Distribution of living and fossil gymnosperms in India. Contributions of Birbal Sahni, Bharadwaj, R.C. Srivastava.
Module 2: Evolution of Angiosperm Morphology (6 hrs) 2.1. Morphological evolution of Angiosperms: Fossil angiosperms and primitive angiosperms. Origin of flowers, stamens, carpels, and nectaries. 2.2. Major theories on angiosperm evolution: The Gnetales–Angiosperm Theory; Euanthial Theory, Pseudanthial theory, The mostly male theory 2. 3. Coevolution with pollinators: Pairwise, Diffuse and Guild coevolutios. 2.4. Major coevolution theories: Pollinator Shift hypothesis, Mutualistic Coevolution theory, Mosaic coevolution theory; Pollination syndrome concept
Module 3: Plant Taxonomy – Methods, Nomenclature, and Character Analysis (6 hrs) 3.1. Methods of Plant Exploration and Identification: Field exploration, plant collection, herbarium techniques. Identification keys: indented and bracketed. Importance of flora in taxonomy. 3.2. Botanical Nomenclature and ICN. History and development. Effective and valid publication, typification, conserved names, hybrid and cultivated plant nomenclature. 3.3. Sources of Taxonomic Characters: Morphology, anatomy, embryology, palynology, cytology, phytochemistry. Primitive and advanced characters, their taxonomic significance. 3.4. Modern Trends in Taxonomy**.** Cladogram and Adansonian principles Phylogenetic systematics, tree-building methods (Maximum Likelihood, Bayesian), DNA barcoding
Module 4. Morphological Description of Angiosperms 21 hrs Describing plant family in technical terms based on habit, habitat, root, stem, leaf, inflorescence, bract, flower, fruit and seed 4.1. Ranunculaceae, Magnoliaceae, Menispermaceae, Polygalaceae, Caryophyllaceae, Capparidaceae, Sterculiaceae, Geraniaceae 4.2. Sapindaceae, Rhizophoraceae, Melastomataceae, Passifloraceae, Aizoaceae, Gentianaceae. 4.3. Boraginaceae, Convolvulaceae, Oleaceae, Lentibulariaceae, Bignoniaceae, Scrophulariaceae, Pedaliaceae 4.4. Lauraceae, Loranthaceae, Amaryllidaceae, Commelinaceae, Araceae, Cyperaceae
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 9Hrs** Modern molecular views on flower: Regulatory genes for pigmentation (anthocyanin pathway genes), flower size and shape (TCP, CYC, RAD genes) and floral scent (terpenoid synthase genes). Importance of CYCLOIDEA gene in floral symmetry. **Practical 30 Hrs** 1. Herbarium preparation of 20 specimens 2. Taxonomic study of any 20 families given in the syllabus. 3. Digital herbarium preparation. 4. Taxonomic key preparation 5. Plant identification using a flora 6. Field visits 7. Visiting Herbaria

Suggested Assignment Topics- Theory

1. Molecular basis of flower development
2. Floral variations within a genera/ even in a species
3. Reasons for discrepancies between several classifications

Suggested Assignment Topics- Practical

1. Photo documentation of campus flora
2. Preparation of bracketed and intended key by taking any 5 plants
3. Practising the describing of plants in technical terms

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Agnihotri, P., & Khuraijam, J. S. (Eds.). (2019). *Angiosperm Systematics: Recent Trends and Emerging Issues (Felicitation Volume in Honour of Dr. Tariq Husain)*. IBP Books.
2	APG IV. (2016). An update of the Angiosperm Phylogeny Group classification. *Botanical Journal of the Linnean Society, 181*(1), 1–20.
3	Baruah, A. (2011). *Handbook of Angiosperm Taxonomy and Useful Plants*. Aavishkar Publishers.
4	Beck, C. B. (2010). *An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century* (2nd ed.). Cambridge University Press.
5	Bierhorst, D. W. (1971). *Morphology of Vascular Plants (Lower Groups)*. Macmillan.
6	Bold, H. C., Alexopoulos, C. J., & Delevoryas, T. (1987). *Morphology of Plants and Fungi*. Harper & Row.
7	Choudhary, S. S. (1997). *A Concise Textbook of Botany (Cryptogams & Gymnosperms)*. New Delhi: CBS Publishers & Distributors.
8	Christenhusz, M. J. M., Fay, M. F., & Chase, M. W. (2017). *Plants of the World: An Illustrated Encyclopedia of Vascular Plants*. Kew Publishing.
9	Christenhusz, M. J. M., Reveal, J. L., Farjon, A., Gardner, M. F., Mill, R. R., & Chase, M. W. (2011). A new classification and linear sequence of extant gymnosperms. *Phytotaxa, 19*, 55–70.
10	Crepet, W. L., & Niklas, K. J. (2009). Darwin’s second “abominable mystery”: Why are there so many angiosperm species? *American Journal of Botany, 96*(1), 366–381.
11	Cronquist, A. (1988). *The Evolution and Classification of Flowering Plants* (2nd ed.). New York Botanical Garden.
12	Eames, A. J. (1961). *Morphology of the Angiosperms*. McGraw-Hill.
13	Endress, P. K. (1994). *Diversity and Evolutionary Biology of Tropical Flowers*. Cambridge University Press.
14	Endress, P. K. (2010). *The evolution of floral biology*. *Annals of Botany, 104*(8), 1353–1372.
15	Fenster, C. B., Armbruster, W. S., Wilson, P., Dudash, M. R., & Thomson, J. D. (2004). Pollination syndromes and floral specialization. *Annual Review of Ecology, Evolution, and Systematics, 35*, 375–403.
16	Friis, E. M., Crane, P. R., & Pedersen, K. R. (2011). *Early Flowers and Angiosperm Evolution*. Cambridge University Press.
17	Friis, E. M., Crane, P. R., & Pedersen, K. R. (2011). *Early Flowers and Angiosperm Evolution*. Cambridge University Press.
18	Gupta, R. P. (2012). *Textbook of Systematic Botany* (7th ed.). CBS Publishers & Distributors.
19	Herrera, C. M., & Pellmyr, O. (Eds.). (2002). *Plant–Animal Interactions: An Evolutionary Approach*. Blackwell.

20	Heywood, V. H., Brummitt, R. K., Culham, A., & Seberg, O. (2007). *Flowering Plant Families of the World*. Royal Botanic Gardens, Kew.
21	Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). *Plant Systematics: A Phylogenetic Approach* (4th ed.). Sinauer Associates.
22	Kaur, I., & Uniyal, P. L. (2019). *Textbook of Gymnosperms: Based on CBCS Syllabus of University of Delhi*. New Delhi: [Publisher].
23	Khanna, K. K., Singh, N. P., & Mudgal, V. (201X). *Flora of Madhya Pradesh: Angiosperms (Hydrocharitaceae to Poaceae) and Gymnosperms (Vol. III)*. Botanical Survey of India.
24	Pellmyr, O. (2003). Yuccas, yucca moths, and coevolution: A review. *Annals of the Missouri Botanical Garden, 90*(1), 35–55.
25	Pullaiah, T., & Karuppusamy, S. (2018). *Taxonomy of Angiosperms* (4th rev. ed.). New Delhi: [Publisher].
26	Pusalkar, P. K., & Srivastava, S. K. (2018). *Flora of Uttarakhand: Vol. 1 – Gymnosperms and Angiosperms (Ranunculaceae–Moringaceae)*. IBP Books.
27	Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2020). *Biology of Plants* (9th ed.). W. H. Freeman and Co.
28	Sahni, B. (1948). *The Pentoxyleae: A New Group of Gymnosperms from the Jurassic of India*. Bot. Gazette.
29	Sambamurty, A. V. S. S. (2019). *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*. Dreamtech Press.
30	Simpson, M. G. (2019). *Plant Systematics* (3rd ed.). Academic Press.
31	Sokal, R. R., & Sneath, P. H. A. (1963). *Principles of Numerical Taxonomy*. W. H. Freeman.
32	Soltis, D. E., Soltis, P. S., & Chase, M. W. (2019). *Phylogeny and Evolution of Angiosperms*. University of Chicago Press.
33	Srivastava, R. C. (1992). *Fossil Gymnosperms of India*. Today & Tomorrow's Printers.
34	Stuessy, T. F. (2009). *Plant Taxonomy: The Systematic Evaluation of Comparative Data* (2nd ed.). Columbia University Press.
35	Stuessy, T. F., & Lack, H. W. (2011). *Monographic Plant Systematics: Fundamental Assessment of Plant Biodiversity*. Regnum Vegetabile.
36	Takhtajan, A. (1991). *Evolutionary Trends in Flowering Plants*. Columbia University Press.
37	Takhtajan, A. (2009). *Flowering Plants*. Springer.
38	Taylor, T. N., Taylor, E. L., & Krings, M. (2009). *Paleobotany: The Biology and Evolution of Fossil Plants*. Academic Press.
39	Willis, K. J., & McElwain, J. C. (2014). *The Evolution of Plants* (2nd ed.). Oxford University Press.
40	Yadav, S. (2022). *Plant Systematics & Angiosperm Taxonomy*. Mahaveer Publications.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Visit to herbaria ➢ Field visits	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical examination	10

Employability for the Course / Programme

This course equips students with the foundational and advanced knowledge required for careers in plant taxonomy, biodiversity conservation, forestry, herbarium curation, ecological research, environmental consultancy, and plant biotechnology.

29	Advanced course in Mycology, Microbiology and Plant pathology		KU7DSCPLS404
DSC	Semester: 7	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 301-399 level
2. Ability to write examination in English

Course Outcomes	
CO1	Identify and classify bacteria, fungi, and viruses using classical and molecular methods.
CO2	Analyze microbial growth, metabolism, and adaptations to different environments.
CO3	Apply knowledge of plant–microbe interactions in agriculture and environmental biotechnology.
CO4	Demonstrate understanding of fungal ecology and use fungi in industrial and medicinal applications.
CO5	Implement strategies for plant disease diagnosis, management, and prevention using modern tools

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course provides an integrated understanding of microorganisms, fungi, and plant pathogens.
• *First module explores the structural, physiological, and metabolic diversity of microorganisms.* • *Next module introduces the biology of viruses and microbial ecological roles, highlighting plant–microbe interactions, nitrogen fixation, and the use of molecular tools for ecological and evolutionary studies.* • *Third module focuses on fungal taxonomy, morphology, and physiology, with special emphasis on their ecological functions, industrial uses, and medical importance, including recent advances in fungal biotechnology.* • *Last module examines plant–pathogen interactions, mechanisms of host defense, and modern disease management approaches integrating biological, chemical, and technological methods for sustainable agriculture.*
This course will help to focus on microbial diversity, taxonomy, physiology, ecological roles, and applications in biotechnology and agriculture.

Course Objectives:

1. Understand the diversity, structure, and physiology of microorganisms.
2. Learn classification, identification, and molecular tools for microbes and fungi.
3. Explore virus biology, microbial ecology, and plant–microbe interactions.
4. Study fungal morphology, taxonomy, and their industrial, agricultural, and medical applications.
5. Gain knowledge of plant diseases, host–pathogen interactions, and modern disease management strategies.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Microbiology 12 hrs
1.1 **Microbial Cell Structure and Physiology:** Bacterial cell wall, capsule, slime layers, flagella, pili/fimbriae. Morphology of specialized bacteria: spirochetes, rickettsias, chlamydias, mycoplasmas, actinomycetes, archaeobacteria (extremophiles). Growth kinetics, generation time, growth curve, aerobic/anaerobic culture systems. Microbial metabolism and adaptation to environmental extremes

1.2. **Microbial Taxonomy and Phylogeny:** Bergey's Manual-based classification of bacteria. Molecular and biochemical identification methods. Molecular and genomic tools: DNA/RNA homology, G+C content, rRNA sequencing, DNA barcoding. chemotaxonomy (cell wall, lipid, quinone analysis). Serological and ecological approaches to microbial classification. 1.3. **Methods in Microbiology:**Culture techniques: media preparation, sterilization, isolation of pure cultures, anaerobic cultivation. Maintenance of microbial cultures and estimation of microbial biomass. 1.4. **Applied Microbiology and Industrial Microbiology:** Fermentation technology: upstream and downstream processing, fermenter design. Industrial, Environmental and agricultural applications. Bioremediation- microbial pollution control. Microbial biotechnology.
Module 2: Virology, Microbial Ecology, and Plant-Microbe Interactions (9 hrs) 2.1. **Virology and Acellular Entities:** Plant, animal viruses, bacteriophages, viroids, prions. Virus structure, genome types (DNA/RNA), envelopes, viral replication, and life cycles. Virus cultivation and assay: embryonated eggs, experimental animals, cell cultures (mono- and suspension cultures). Viral applications in cancer biology and biotechnology. 2.2. . **Microbial Ecology:** Microbial roles in biogeochemical cycles and nutrient turnover. Microbes in terrestrial, freshwater, and marine environments. Extremophiles and their adaptations. Microbial associations with plants: symbiosis, mutualism, commensalism, parasitism 2. 3. **Applied Plant-Microbe Interactions:** Nitrogen-fixing bacteria: Rhizobium, Azotobacter, Anabaena, Nostoc, Frankia. Biocontrol agents and plant growth-promoting microbes. Microbes in agriculture and environmental restoration. Use of molecular tools (DNA barcoding, metagenomics) for microbial ecology studies 2.4. **Modern Tools and Techniques in Microbial Studies:** High-throughput sequencing, PCR, qPCR, CRISPR-based tools. Biosensors, bioinformatics for microbial phylogeny and functional prediction. Imaging: confocal microscopy, fluorescence tagging, flow cytometry. Environmental monitoring: microbial indicators, metagenomics, eDNA analysis.
Module 3: Mycology and Applications 9 hrs 3.1. Fungal Classification and Morphology**:** Phylum-level classification: Chytridiomycota, Zygomycota, Glomeromycota, Ascomycota, Basidiomycota, Deuteromycetes: Salient fatures of these groups and their life cycle. General topics on fungi: Comparative fungal cell walls and fruiting bodies. Parasexuality in Fungi. Types of fungal spores. 3.2. Food and fermentation industries: yeast, edible fungi, enzyme production. Fungi in Agriculture: plant pathogens, mycorrhizal inoculants, biocontrol agents. 3.3. Medical mycology: Major fungal diseases in human beings. fungal pathogens, antifungal drugs, resistance mechanisms. Mycotoxins. Fermentation and bioreactor design for fungi. Antibiotics 3.4. Modern Tools and Techniques in Mycology**:** Microscopy: SEM, TEM, fluorescence, confocal imaging. Molecular identification: DNA barcoding, ITS sequencing, metagenomics. Bioinformatics and computational tools for fungal taxonomy and metabolite analysis
Module 4. Plant Pathology and Biotechnology 9 hrs 4.1. Plant Disease and Host-Parasite Interaction: Major plant pathogens. Disease development. Host defense mechanisms: structural, biochemical, phytoalexins, secondary messengers. Gene-for-gene and protein-for-protein interaction concepts. 4.2.. Plant Disease Management: Biological control: antagonists, mode of action, cross-protection. Cultural practices: crop sanitation, disease-free propagules, vector control.

Chemical control: fungicides, systemic and post-harvest treatments. Integrated Pest and Disease Management (IPDM)

4.3. Major Plant Diseases in India: Cereals: rice blast, bacterial blight: Vegetables: tomato bacterial wilt, chili seedling wilt: Fruits: Anthracnose of Mango. papaya mosaic: Other crops: coconut grey leaf spot, tea blister blight, rubber powdery mildew.

4.4. Modern Tools and Techniques in Plant Pathology: Remote sensing, GIS, and UAV-based monitoring for disease mapping. Genetic engineering and transgenic approaches for disease resistance.

Module 5. TEACH SPACE 12 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 2Hrs

Staining of microbes various methods. Gram staining for bacteria. Protocols of streak plate method. Fungal Culture in PDA medium. Structure of TMV, Structure of Lambda phage.

Practical 10 Hrs

1. Gram Staining of bacteria
2. Streak plate method
3. PDA fungal culture
4. Endospore staining
5. Examination of root nodules
6. Fungal spore staining
7. Control measure for the diseases mentioned in the syllabus
8. Field visit to pathology labs
9. Collection, preservation and submission of fungi. 2.
10. Fungal genus-morphological anatomical study. Collection and study of the types mentioned below and their identification up to generic level: Synchytrium, Pilobolus, Mucor, Claviceps, Xylaria, Geoaster Auricularia, Cyathus, Polyporus and Ustilago.(Any 6 genera)
11. Microscopic photographs/Photographs of fungi from various fields, taken by the student, can be printed and submitted in the record as separate sheets

Suggested Assignment Topics- Theory

1. Salient features of fungal groups
2. Comparison of spores in fungi
3. Reproduction in viruses
4. Plant pathological specimen collection protocol for herbaria making

Suggested Assignment Topics- Practical

1. Other staining methods
2. Pathological survey
3. Use of microbes to enhance plant growth
4. Mushroom cultivation

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Agrios, G. N. (2005). Plant Pathology (5th ed.). Elsevier Academic Press.
2	Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). Introductory Mycology (4th ed.). Wiley.
3	Ananthanarayan, R., & Paniker, C. K. J. (2013). Textbook of Microbiology (10th ed.). Universities Press.

4	Aneja, K. R. (2019). Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production (5th ed.). New Age International.
5	Choudhary, D. K., & Johri, B. N. (2009). Interactions of Bacillus spp. and plants – With special reference to induced systemic resistance (ISR). Microbiological Research, 164(5), 493–513.
6	Christenhusz, M. J. M., Fay, M. F., & Chase, M. W. (2011). Plants of the World: An Illustrated Encyclopedia of Vascular Plants. Kew Publishing.
7	Dubey, R. C., & Maheshwari, D. K. (2018). A Textbook of Microbiology (3rd ed.). S. Chand Publishing.
8	Kaur, S., & Singh, H. (2014). Microbial biocontrol agents: Mechanisms and applications in agriculture. Journal of Plant Pathology & Microbiology, 5(10), 1–8.
9	Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). Brock Biology of Microorganisms (16th ed.). Pearson.
10	Mehrotra, R. S., & Aggarwal, R. (2019). Plant Pathology (4th ed.). Tata McGraw-Hill.
11	Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2015). Microbiology (5th ed.). Tata McGraw-Hill.
12	Prescott, L. M., Harley, J. P., & Klein, D. A. (2021). Microbiology (11th ed.). McGraw-Hill Education.
13	Rangaswami, G., & Ganesan, K. (2010). Plant Diseases of Importance to India (2nd ed.). ICAR Publication.
14	Rangaswami, G., & Mahadevan, A. (2009). Diseases of Crop Plants in India (5th ed.). Prentice Hall of India.
15	Singh, R. S., & Singh, R. S. (2017). Fundamentals of Microbiology (3rd ed.). Kalyani Publishers.
16	Singh, S., & Singh, N. (2012). Post-harvest diseases of mango in India and management strategies. Journal of Horticultural Science, 7(2), 45–53.
17	Sinha, R., & Sharma, R. (2017). Nitrogen-fixing bacteria in agriculture: A review. Indian Journal of Microbiology, 57(2), 145–157.
18	Sivasithamparam, K., & Gopalaswamy, R. (2001). Microbial Ecology and Plant Growth. New India Publishing.
19	Srivastava, A., & Kumar, P. (2018). Fungal endophytes of medicinal plants: Diversity and applications. Journal of Applied Microbiology, 125(4), 1019–1033.
20	Tortora, G. J., Funke, B. R., & Case, C. L. (2020). Microbiology: An Introduction (13th ed.). Pearson.
21	Tripathi, P., & Singh, R. (2016). Molecular tools for fungal taxonomy and identification: An overview. Fungal Biology Reviews, 30(3), 145–155.
22	Verma, R., & Dubey, R. C. (2015). Microbial bioremediation of industrial pollutants: Indian perspective. Bioresource Technology, 198, 108–119.
23	Webster, J., & Weber, R. (2007). Introduction to Fungi (3rd ed.). Cambridge University Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with

➢ Field visit ➢ Pathology lab visit	demonstrations and hands on experiences

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical examination	10

Employability for the Course / Programme

This course equips students with practical and theoretical expertise for careers in microbiology, mycology, plant pathology, biotechnology, environmental monitoring, and agricultural disease management sectors.

30	**Modern tools and Techniques for Ecological Studies**		**KU7DSCPLS405**
DSC	**Semester: 7**	**Hrs/week: 4 Theory**	**Credits: 4**

Course Pre-requisite:

1. Knowledge in Biology at 301-399 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain advanced ecological principles governing populations, communities, and ecosystems.
CO2	Analyze causes and effects of environmental pollution and propose sustainable management strategies.
CO3	Evaluate biodiversity conservation techniques and restoration ecology practices.
CO4	Apply modern analytical, molecular, and geospatial tools for environmental monitoring.
CO5	Interpret ecological data to address real-world environmental and sustainability challenges.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course integrates ecological theory, environmental management, and modern analytical tools to equip students with the knowledge and skills necessary for sustainable environmental stewardship and scientific research.
• *First module is introducing fundamental and advanced ecological concepts, emphasizing population and community interactions, succession, and ecosystem dynamics.* • *Second module explores the ecological impacts of pollution and presents scientific, economic, and policy-based approaches to sustainable environmental management.* • *Third module examines biodiversity patterns, conservation strategies, restoration ecology, and modern monitoring tools used in ecosystem assessment..* • *Final module focuses on the chemical basis of environmental processes and introduces analytical, remote sensing, and GIS-based techniques for environmental monitoring.*
This course will provide you advanced theoretical knowledge on tools and techniques relevant in ecology and environmental science.

Course Objectives:

1. To provide in-depth knowledge of population and community ecology, including ecological and genetic adaptations.
2. To study environmental pollution, its ecological impacts, and the principles of sustainable environmental management.
3. To understand the importance of biodiversity conservation and ecosystem restoration through case studies and modern techniques.
4. To introduce students to environmental chemistry, pollution analysis, and remote sensing technologies.
5. To develop practical skills in ecological data analysis, modelling, and environmental decision-making.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Advanced Concepts in Ecology and Population Dynamics 12 hrs
1.1. Population Ecology (Autecology). Characteristics: size, density, dispersion, age structure, natality, mortality. Population growth models, environmental resistance, biotic potential, carrying capacity. Positive and negative interactions, migration, subsistence

density. Ecological consequences of overpopulation 1.2. Genecology and Ecotypes: Ecological amplitude, ecads, ecotypes, ecospecies, coenospecies. Adaptation and evolution in heterogeneous environments. Population genetics in natural habitats 1.3. Community Ecology (Synecology): Community formation processes. Community classification: dynamic systems (Clements), criteria, and synthetic characteristics. Sorensen's similarity index, coefficient of communities. Dynamic community characteristics: cyclic and non-cyclic replacement 1.4. Succession and Ecosystem Dynamics: Concepts of primary and secondary succession, autotrophic and heterotrophic changes. Retrogressive succession, climax communities, community resilience. Energy flow, nutrient cycling, and ecosystem stability
Module 2: Pollution Ecology and Environmental Management 12 hrs 2.1. Pollution Ecology: Types, Causes and Effects of air, water, and soil pollution on ecosystems, biodiversity, and human health. Biogeochemical and photochemical reactions in the atmosphere. Particulates, aerosols, turbidity, and climate impacts 2.2.. Waste Management: Solid, biomedical, and hazardous waste: sources, characterization, and disposal. Treatment methods: composting, incineration, bioaugmentation, phytoremediation. Degradation of pesticides, plastics, polymers, and industrial chemicals. Environmental audit: energy, water, and green audits 2. 3. Environmental Management & Sustainable Development: Human-environment interactions, resource utilization, and ecological footprints. Guidelines for sustainability and poverty reduction. Role of national and international agencies (UNESCO, MAB, CPCB, NGOs). Agricultural and industrial sustainability strategies 2.4. Environmental Economics & Policy Tools. Economic evaluation of pollution control, cost-benefit analysis. Environmental laws, Earth Summits and protocols, and management strategies. Disaster management, risk analysis, and regulatory frameworks
Module 3: Biodiversity, Conservation, and Restoration Ecology 12 hrs 3.1. Conservation Ecology and Biodiversity: RET species, keystone species, hotspots, IUCN Red List. Biodiversity levels: species, community, ecosystem, landscape. Causes of biodiversity loss and threats to ecosystems. 3.2. Conservation Strategies: In-situ and ex-situ conservation: National Parks, Sanctuaries, Biosphere Reserves, Sacred Groves, Botanic Gardens. Community participation, indigenous knowledge, ecotourism. Role of biotechnology in conservation (seed banks, tissue culture). 3.3. Restoration Ecology and Case Studies: Ecosystem restoration concepts, UN Decade on Ecosystem Restoration. Case studies: Ganga River, Chernobyl, London/Delhi smog, Endosulfan, Taj Mahal. Chipko, Silent Valley Movement, 3.4. Modern Monitoring Tools for Biodiversity and Ecosystems: GIS, Remote Sensing, GPS, geospatial mapping, geotagging. Molecular tools: DNA barcoding, environmental DNA (eDNA). Biomonitoring using indicator species and bioassays. Modelling ecosystem health and restoration success
Module 4. Environmental Chemistry and Analytical Techniques 12 hrs 4.1. Atmospheric Chemistry and Pollution: Chemical reactions, photochemical smog, ozone depletion, greenhouse gases. Sources and effects of aerosols, particulate matter, heavy metals. 4.2. Water and Soil Chemistry: Water pollutants: heavy metals, organics, microplastics, radioactive materials. Eutrophication, groundwater contamination, potable water quality. Soil contamination: pesticide residues, industrial effluents, remediation techniques 4.3. Remote Sensing & GIS in Environmental Science: Principles of remote sensing, data acquisition, image processing. GIS fundamentals, spatial analysis, geospatial variability,

mapping pollution hotspots. Applications in natural resource management, biodiversity monitoring, and disaster management

4.4. Analytical Tools and Techniques: Environmental sensors, drones, LiDAR, satellite-based monitoring. Biomarkers and molecular indicators for ecosystem health. Risk assessment, modelling environmental impacts, decision-support systems.

Module 5. TEACH SPACE 12 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 2Hrs

Portable Photosynthesis System, Soil pH and Conductivity Meter, Soil Respiration Analyzer, CO_2 Flux Meter, Portable X-ray Fluorescence (pXRF) Spectrometer, Turbidimeter, Nephelometer, Aethalometer / Aerosol Spectrometer, Gas Analyzer (e.g., CO_2, NOx, SO_2 Analyzers), Particulate Matter (PM) Monitor.

Practical 10 Hrs

1. Estimation of DO2,BOD and Primary productivity using Winkler method from fresh water, estuarine and marine waters and comparison and report submission.
2. Assessment of DCO2
3. Estimation of soil PH
4. Estimation of Light intensity using Lux meter
5. Estimation of rate of photosynthesis using Photosynthesis meter

Suggested Assignment Topics- Theory

1. Various eco-movements in Kerala and India
2. National parks and hotspots in India
3. Types, causes and impacts of pollution
4. Electromagnetic pollution
5. Light as a pollutant
6. Oxygen as a pollutant
7. Ozone as pollutant
8. Global warming and its impacts
9. New tools and techniques in ecology

Suggested Assignment Topics- Practical

1. GIS study of a polluted area/mining area/quarry
2. Photosynthetic rate estimation in plants of polluted areas

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Begon, M., Townsend, C.R., & Harper, J.L. (2021). *Ecology: From Individuals to Ecosystems*. Wiley-Blackwell.
2	Chapman, J.L. & Reiss, M.J. (2008). *Ecology: Principles and Applications*. Cambridge University Press.
3	Clewell, A.F. & Aronson, J. (2013). *Ecological Restoration: Principles, Values, and Structure of an Emerging Profession*. Island Press.
4	Cunningham, W.P. & Cunningham, M.A. (2020). *Environmental Science: A Global Concern*. McGraw Hill.
5	Dash, M.C. (2020). *Fundamentals of Ecology*. McGraw Hill India.
6	Gadgil, M. & Guha, R. (1995). *Ecology and Equity: The Use and Abuse of Nature in Contemporary India*. Routledge.
7	Groom, M.J., Meffe, G.K., & Carroll, C.R. (2006). *Principles of Conservation Biology*. Sinauer Associates.

8	Hem, J.D. (1985). *Study and Interpretation of the Chemical Characteristics of Natural Water*. USGS Water-Supply Paper 2254.
9	Hunter, M.L. (1996). *Fundamentals of Conservation Biology*. Blackwell Science.
10	Jensen, J.R. (2015). *Introductory Digital Image Processing: A Remote Sensing Perspective*. Pearson.
11	Krebs, C.J. (2014). *Ecology: The Experimental Analysis of Distribution and Abundance*. Pearson.
12	Lillesand, T., Kiefer, R., & Chipman, J. (2015). *Remote Sensing and Image Interpretation*. Wiley.
13	Maiti, S.K. (2013). *Handbook of Methods in Environmental Studies*. ABD Publishers.
14	Manahan, S.E. (2017). *Environmental Chemistry*. CRC Press.
15	Odum, E.P. & Barrett, G.W. (2005). *Fundamentals of Ecology*. Thomson Brooks/Cole.
16	Odum, H.T. (1994). *Ecological and General Systems*. University Press of Colorado.
17	Peavy, H.S., Rowe, D.R., & Tchobanoglous, G. (2013). *Environmental Engineering*. McGraw Hill.
18	Primack, R.B. (2020). *Essentials of Conservation Biology*. Oxford University Press.
19	Raven, P.H., Berg, L.R., & Hassenzahl, D.M. (2012). *Environment*. Wiley.
20	Ricklefs, R.E. (2008). *The Economy of Nature*. W.H. Freeman.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical examination	10

Employability for the Course / Programme

This course enhances employability by preparing graduates for careers in environmental research, pollution monitoring, biodiversity conservation, ecological consultancy, and sustainability management across academic, governmental, and industrial sectors.

31	ADVANCED BIOINFORMATICS		KU8DSCPLS406
DSC	Semester: 8	Hrs/week: 3 Theory + 1 PRACTICAL	Credits: 4

Course Pre-requisite:
1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Retrieve, manage, and interpret data from major biological databases.
CO2	Perform sequence alignment, phylogenetic, and comparative genomic analyses.
CO3	Apply fundamental principles of functional genomics.
CO4	Integrate multi-omics data using systems biology and machine learning tools.
CO5	Conduct basic bioinformatics and sequence analysis experiments independently

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		

CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This is an advanced undergraduate course designed for getting a comprehensive idea on genomics and functional genomics.

- *First module is dealing with basics of biological databases, data organization, and mining strategies.*
- *Second module explores alignment algorithms, phylogenetic analysis, and genome comparison to understand evolutionary and functional relationships.*
- *Third module helps to integrate multi-omics data and model biological systems through computational and statistical frameworks.*
- *Final module supports to develop applied understanding of analytical pipelines, data management, and cross-platform integration..*

This course will provide opportunities to get a strong foundation in advanced bioinformatics both theoretically and experientially.

Course Objectives:

1. Understand and compare the structure, organization, and utility of major biological databases, and perform data mining for genomic and proteomic information.
2. Apply and critically evaluate sequence alignment, annotation, and comparative genomics techniques to investigate biological relationships.
3. Integrate multi-omics data to analyze gene expression, pathways, and biological networks using systems biology frameworks.
4. Design and implement reproducible analytical pipelines using modern bioinformatics tools, data standards, and workflow systems.
5. Interpret and communicate biological insights derived from computational analyses with awareness of algorithmic logic, data quality, and research relevance.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	35	65	100

COURSE CONTENT

Module 1: Biological Databases and Data Mining 12 hours

1.1. Overview of Biological Databases: Types: Primary, Secondary, and Specialized Databases. Comparison between GenBank, EMBL, and DDBJ – data structure, update frequency, and curation. Protein databases: UniProt, RefSeq – annotation pipelines and data formats (FASTA, GenBank, XML).

1.2. Genome and Transcriptome Resources: Browsers: Ensembl, UCSC Genome Browser, Transcriptome repositories: GEO, ArrayExpress – structure, metadata standards, query formulation. Functional annotation: Gene Ontology (GO), KEGG, Reactome – ontology terms, relationships, and biological interpretation. GO vs. KEGG (hierarchical ontology vs. pathway representation).

1.3. Data Mining and Querying Techniques: SQL vs. NoSQL in bioinformatics – structural differences, advantages, and applications. Text mining, pattern recognition, and motif discovery. Sequence similarity searching: BLAST vs. FASTA – algorithms, scoring systems, sensitivity comparison.

1.4. Next-Generation Data Repositories and Metadata Analysis: NGS databases: SRA, ENA, TCGA – structure, data submission, and retrieval. Data preprocessing steps: Quality control, filtering, and normalization.

Module 2: Sequence Analysis and Comparative Genomics 12 hours

2.1. **Sequence Alignment and Analysis:** Pairwise and multiple sequence alignment; scoring matrices (PAM, BLOSUM); alignment algorithms (Needleman–Wunsch, Smith–Waterman).

2.2. **Phylogenetics and Evolutionary Analysis:** Tree construction (Neighbor-Joining, Maximum Likelihood, Bayesian inference); molecular evolution models, bootstrapping.

2. 3.**Genome Annotation and Comparative Genomics** Structural and functional annotation; gene prediction; ortholog/paralog identification.

2.4.**Transcriptome and Variant Analysis:** RNA-Seq pipelines; SNP/indel detection; functional impact prediction.

Module 3: Functional Genomics, Systems Biology, and Network Analysis (12 hours)

3.1. Functional Genomics and Pathway Mapping: Integration of transcriptomic, proteomic, and metabolomic datasets. DAVID, GSEA, Reactome, KEGG Mapper.

3.2. Systems Biology and Network Analysis: Gene regulatory networks, metabolic pathways, protein–protein interaction (PPI) networks. Cytoscape, STRING, Gephi. Network metrics: degree, centrality, modularity.

3.3. High-Throughput Data Integration and Machine Learning Applications: Supervised vs. unsupervised learning in bioinformatics. Applications: clustering of expression data, disease classification, and feature selection. Traditional statistics vs. ML approaches – interpretability vs. predictive power.Tools: Scikit-learn, TensorFlow in omics data analysis.

3.4. Data Standards, Reproducibility, and FAIR Principles. Concepts of data sharing, metadata standards, and open science. Workflow automation tools: Galaxy, Snakemake, Nextflow.

Module 4. Advanced Bioinformatics Tools and Analytical Pipelines (12 hours)

4.1. Bioinformatics Tools and Frameworks: Overview of EMBOSS, Bioconductor, Biopython, and Galaxy. Command-line vs. GUI tools – speed, flexibility, and scalability.

4.2. Workflow Design and Automation: Pipeline creation, modularity, and version control. Workflow management systems: Galaxy vs. Snakemake vs. Nextflow – comparative features and use cases.

4.3. Data Visualization and Interpretation: Use of R, Python (Matplotlib, Seaborn) for genomics visualization. Visualization strategies: heatmaps, volcano plots, PCA, and network maps.

4.4. Applications, Case Studies, and Future Directions: Comparative study of genome annotation tools, disease gene prediction workflows, and omics integration case studies.

Module 5. TEACH SPACE 9 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 9Hrs

Basics of Protein Engineering and Designing. Structure based Drug designing. Docking.

Practical 30 Hrs

1. Exploring NCBI and UniProt databases for gene/protein information
2. Retrieving sequences in FASTA format and converting between file types
3. Performing pairwise sequence alignment using BLAST
4. Conducting multiple sequence alignment using Clustal Omega
5. Identifying conserved domains and motifs using Pfam and PROSITE
6. Building a phylogenetic tree using MEGA or Phylogeny.fr

Suggested Assignment Topics- Theory
1. Characteristics of each databases
2. Comparison of different tools used in bioinformatics
3. Applications of multi-omics.

Suggested Assignment Topics- Practical
1. Predicting secondary structure using PSIPRED
2. Visualizing protein structures using PyMOL or Chimera
3. Annotating genes with KEGG or GO terms
4. Creating a basic workflow in Galaxy or Bioconductor for sequence analysis
5. Creating a report and interpretation summary – from raw sequence to biological conclusion

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Aloy, P., & Russell, R. B. (2006). Structural systems biology: Modelling protein interactions. Nature Reviews Molecular Cell Biology, 7(3), 188–197. https://doi.org/10.1038/nrm1858
2	Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. Journal of Molecular Biology, 215(3), 403–410. https://doi.org/10.1016/S0022-2836(05)80360-2
3	Andrews, S. (2010). FastQC: A quality control tool for high throughput sequence data. Babraham Bioinformatics. https://www.bioinformatics.babraham.ac.uk/projects/fastqc/
4	Ashburner, M., Ball, C. A., Blake, J. A., Botstein, D., Butler, H., Cherry, J. M., et al. (2000). Gene Ontology: Tool for the unification of biology. Nature Genetics, 25(1), 25–29. https://doi.org/10.1038/75556
5	Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A practical guide to the analysis of genes and proteins (3rd ed.). Wiley-Blackwell.
6	Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. Journal of the Royal Statistical Society: Series B, 57(1), 289–300.
7	Bioconductor Project. (2024). Bioconductor: Open software for bioinformatics. https://www.bioconductor.org
8	Burley, S. K., Bhikadiya, C., Bi, C., Bittrich, S., Chen, L., Crichlow, G. V., et al. (2021). RCSB Protein Data Bank: Powerful new tools for exploring 3D structures of biological macromolecules. Nucleic Acids Research, 49(D1), D437–D451. https://doi.org/10.1093/nar/gkaa1038
9	Consortium, E. P. (2012). An integrated encyclopedia of DNA elements in the human genome. Nature, 489(7414), 57–74. https://doi.org/10.1038/nature11247
10	Edgar, R., Domrachev, M., & Lash, A. E. (2002). Gene Expression Omnibus: NCBI gene expression and hybridization array data repository. Nucleic Acids Research, 30(1), 207–210. https://doi.org/10.1093/nar/30.1.207
11	Finn, R. D., Coggill, P., Eberhardt, R. Y., Eddy, S. R., Mistry, J., Mitchell, A. L., et al. (2016). The Pfam protein families database: Towards a more sustainable future. Nucleic Acids Research, 44(D1), D279–D285. https://doi.org/10.1093/nar/gkv1344
12	Gish, W., & States, D. J. (1993). Identification of protein coding regions by database similarity search. Nature Genetics, 3(3), 266–272. https://doi.org/10.1038/ng0393-266
13	Kanehisa, M., & Goto, S. (2000). KEGG: Kyoto Encyclopedia of Genes and Genomes. Nucleic Acids Research, 28(1), 27–30. https://doi.org/10.1093/nar/28.1.27
14	Lesk, A. M. (2019). Introduction to bioinformatics (5th ed.). Oxford University

	Press.
15	Mount, D. W. (2004). Bioinformatics: Sequence and genome analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
16	National Center for Biotechnology Information (NCBI). (2024). NCBI Databases and Tools. https://www.ncbi.nlm.nih.gov
17	Pevsner, J. (2019). Bioinformatics and functional genomics (3rd ed.). Wiley-Blackwell.
18	Quackenbush, J. (2001). Computational analysis of microarray data. Nature Reviews Genetics, 2(6), 418–427. https://doi.org/10.1038/35076576
19	Szklarczyk, D., Gable, A. L., Lyon, D., Junge, A., Wyder, S., Huerta-Cepas, J., et al. (2019). STRING v11: Protein–protein association networks with increased coverage. Nucleic Acids Research, 47(D1), D607–D613. https://doi.org/10.1093/nar/gky1131
20	Tamura, K., Stecher, G., & Kumar, S. (2021). MEGA11: Molecular Evolutionary Genetics Analysis version 11. Molecular Biology and Evolution, 38(7), 3022–3027. https://doi.org/10.1093/molbev/msab120

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal Practical examination	10

Employability for the Course / Programme

Student on successful completion will be best suited for the research as well as jobs on biological data systems, comparative genomics, systems biology, and computational methods

32	Phytogeography of North Kerala		KU8DSCPLS407
DSC	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the major geomorphological, climatic, and ecological determinants that influence plant distribution and vegetation patterns in North Kerala.
CO2	Identify and classify the dominant vegetation types and endemic plant communities characteristic of the region.
CO3	Analyze the impacts of anthropogenic activitieson natural vegetation and biodiversity in different ecological zones.
CO4	Evaluate the significance of conservation strategies in maintaining regional phytodiversity and ecosystem stability.
CO5	Apply field, laboratory, and geospatial research tools to conduct independent investigations in phytogeography and vegetation ecology.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						

CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course explores the floristic, ecological, and geographical diversity of North Kerala, emphasizing the relationship between landforms, climate, and vegetation. It covers geomorphological influences, ecosystem typology, endemic flora, anthropogenic pressures, and conservation practices

- *First module is dealing with geomorphological and ecological features of North Kerala with an emphasis to vegetations and their adaptations.*
- *Second module is giving and idea on the local flora of North Kerala.*
- *Third module is focussing on the resistance of the plants as well as of the local people for the sustenance during the pollution and several natural and anthropogenic threats.*
- *Fourth module is focussing on the tools and techniques for floristic research in North kerala.*

This course will provide you opportunities to know about your locality more to think globally.

Course Objectives:

1. Interpret the geomorphological and climatic determinants of vegetation patterns in North Kerala.
2. Identify and classify major vegetation types and characteristic flora of different ecological zones.
3. Analyze biotic and abiotic pressures affecting vegetation distribution and ecosystem health.
4. Evaluate regional conservation practices and phytogeographical significance of protected areas and sacred groves.
5. Apply modern research tools and geospatial techniques for vegetation mapping, biodiversity assessment, and habitat restoration.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Module I: Geomorphology, Ecosystems, and Plant Adaptations 12 hours

1.1. Major Geomorphological Structures and Implications: Wayanad Plateau, Banasura Hill range, and high-elevation ridges. Escarpments, slopes, and river valley systems (Valapattanam, Chandragiri).Coastal plains, barriers, and lateritic uplands.

1.2. Western Ghats Region of North Kerala: Altitudinal gradients, rainfall patterns, and montane forests. Shola–grassland complexes and riparian vegetation mosaics.

1.3. Laterite Hills and Scrub Ecosystems: Formation of laterite soils, erosion patterns, and characteristic flora. Drought and nutrient-poor soil adaptations in *Lannea coromandelica*,

Wrightia tinctoria, Cleistanthus collinus. 1.4. Coastal and Mangrove Ecosystems: Characteristics of North Kerala Mangroves. Key mangrove species: *Avicennia officinalis, Rhizophora mucronata, Bruguiera gymnorhiza.* Salt tolerance, aerial roots, and vivipary adaptations.
Module 2: Floristic Diversity and Plant Communities of North Kerala 12 hours 2.1. Vegetation Types and Dominant Plant Groups: Tropical wet evergreen, semi-evergreen, moist deciduous, lateritic scrub, and mangrove vegetation. 2.2. Dominant plants and plant groups. A brief account on flora of north Kerala, including algae, bryophytes, pteridophytes, gymnosperms and angiosperms.Medicinal and Economically Important Plants*: Acorus calamus, Nothapodytes nimmoniana, Rauvolfia serpentina, Cardiospermum halicacabum, Curcuma* spp. Traditional usage patterns and ethnobotanical documentation 2.3. Endemism and Biodiversity Hotspots: Western Ghats as a global biodiversity hotspot. Notable local endemics: *Dipterocarpus indicus, Syzygium travancoricum, Gluta travancorica*. Relevance of endemic richness for conservation prioritization. 2.4. Sacred Groves and Cultural Plant Conservation: Ecological and spiritual importance of Kavus. Poyilkavu (Kozhikode), Neeliyar Kottam (Kannur), Kanathoor (Kasaragod).Role in in-situ conservation of rare and medicinal flora.
Module 3: Resistance to threats through Conservation Movements 12 hrs 3.1. Human-Modified and Plantation Landscapes: Ecological effects of rubber, coconut, cashew, and spice plantations. Edge effects, habitat fragmentation, and biodiversity loss. 3.2. Anthropogenic Threats to Flora: Deforestation, urbanization, overharvesting, quarrying, and sand mining. Case: Quarry impacts on the lateritic hills of Kozhikode and Kannur. 3.3. Pollution and Degraded Ecosystems: Industrial and agricultural pollution affecting Chaliyar and Valapattanam rivers. Effects on riparian vegetation and soil microflora. 3.4. Eco-Movements and Conservation Initiatives: Historical and modern movements: Silent Valley Movement, Malabar Mangrove Action Plan, SEEK's Sacred Grove Preservation. Protected areas: Aralam Wildlife (Butterfly) Sanctuary, Wayanad Wildlife Sanctuary. Role of Kerala Forest Department, NGOs, and community-driven conservation
Module 4: Applied Phytogeography and Research Tools 12 hours 4.1. Economic Plant Utilization: Spices: Elettaria cardamomum, Piper nigrum, Syzygium aromaticum. Cultivation impacts on native vegetation. Timber and NTFPs: Teak, bamboo, honey, essential oils. Need of sustainable harvesting. 4.2. Industrial Interactions and Environmental Impacts: Effects of rubber, coir, and cashew industries on ecosystem integrity. Environmental audit of local processing units. 4.3. Restoration and Habitat Management: Afforestation and rewilding with native species (*Terminalia paniculata, Hopea ponga*). Wetland and mangrove rehabilitation programs in Kadalundi and Bekal. 4.4. Tools and Techniques for Botanical Research: Field: Quadrat and transect sampling, vegetation profiling, herbarium preparation. Lab: DNA barcoding, phytochemical screening, seed germination studies. Geospatial: Remote sensing, GIS-based vegetation mapping, habitat fragmentation and diversity analysis.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5Hrs** Western Ghats: The World Heritage Centre as well as Biodiversity hot spot. Reports on Western ghats Gadgil Committee report, Kasturirangan report, etc

Practical 10 Hrs

1. Biomonitoring using indicator species
2. Soil and water quality analysis
3. GIS-based habitat loss assessment
4. Long-term vegetation monitoring
5. Carbon sequestration studies
6. Environmental impact assessment (EIA)
7. Land-use change analysis
8. local field visit sites such as Aralam, Kadalundi, and Neeliyar Kottam
9. Collection of different types of soils

Suggested Assignment Topics- Theory

1. Differences between Kasthurirangan and Gadgil reports
2. Western ghat biodiversity
3. Mangrove diversity of north Kerala
4. Laterite hill flora and fauna

Suggested Assignment Topics- Practical

1. Quadrat analysis of mangrove areas
2. Calculating the IVI and Diversity Indices of mangroves and grass land ecosystems

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Anilkumar, N. (2002). *Ecological studies on sacred groves of Kerala.* Kerala Forest Research Institute (KFRI) Research Report No. 230.
2	Balakrishnan, N. P., & Henry, A. N. (1992). *Flora of Tamil Nadu, India.* Botanical Survey of India.
3	Champion, H. G., & Seth, S. K. (1968). *A revised survey of the forest types of India*. Government of India Press.
4	Chandran, M. D. S., & Gadgil, M. (1993). Sacred groves and sacred trees of Uttara Kannada. *Environmental Conservation, 20*(1), 41–47.
5	Chandran, M. D. S., & Ramachandra, T. V. (2011). *Land cover and land use dynamics of the Western Ghats.* Indian Institute of Science, Bangalore.
6	Daniels, R. J. R. (2001). *Biodiversity of the Western Ghats: An overview.* Ashoka Trust for Research in Ecology and the Environment (ATREE).
7	Das, S., & Jayakumar, S. (2015). Landscape-scale vegetation mapping in the Western Ghats using remote sensing. *Journal of the Indian Society of Remote Sensing, 43*(4), 637–648.
8	Datar, M. N., & Lakshminarasimhan, P. (2013). *Flora of Maharashtra State: Dicotyledons (Vol. 2).* Botanical Survey of India.
9	Davidar, P., Sahoo, S., Mammen, P. C., Acharya, P., Puyravaud, J. P., Arjunan, M., Garrigues, J. P., & Roessingh, K. (2010). Assessing the extent and causes of forest degradation in India. *Biological Conservation, 143*(12), 2937–2944.
10	Gopalan, R., & Nair, S. C. (2011). *Vegetation and biodiversity of the Western Ghats of Kerala*. KFRI Research Report.
11	Gopalan, R., & Nair, S. C. (2011). *Vegetation and biodiversity of the Western Ghats of Kerala.* KFRI Research Report No. 282.
12	Henry, A. N., Kumari, G. R., & Chithra, V. (1987). *Flora of Kerala (Vols. 1–3).* Botanical Survey of India.
13	IIRS–ISRO. (2021). *Remote sensing applications in forest vegetation mapping of the Western Ghats.* Indian Institute of Remote Sensing.
14	IUCN. (2023). *The IUCN Red List of Threatened Species.* https://www.iucnredlist.org
15	Jose, P. A., & Nair, S. M. (2014). Diversity and structure of sacred groves in northern Kerala. *Tropical Plant Research, 1*(2), 53–60.
16	Joshi, N. V., & Gadgil, M. (1991). On the patterns of distribution of species common to

	India and Sri Lanka. *Proceedings of the Indian Academy of Sciences (Animal Sciences), 100*(1), 47–58.
17	Kannan, R., & James, D. A. (1999). Tropical forest bird communities and conservation in the Western Ghats, India. *Journal of the Bombay Natural History Society, 96*(3), 383–398.
18	Kerala Forest Research Institute (KFRI). (2020). *Biodiversity and ecosystem services of Kerala's protected areas.* Peechi: KFRI.
19	Kerala State Biodiversity Board (KSBB). (2019). *People's Biodiversity Register of Wayanad, Kannur, Kozhikode, and Kasaragod Districts.* Government of Kerala.
20	Krishnan, R. M., & Suresh, H. S. (2017). Phytogeographical affinities and endemism in the Western Ghats. *Current Science, 113*(6), 1083–1088.
21	Manoharan, S., & Kumar, S. V. (2015). Plant diversity of lateritic hills of Kannur district, Kerala. *Journal of Economic and Taxonomic Botany, 39*(1–4), 125–136.
22	Menon, S. (2002). *Ecology and conservation of tropical rain forests in India.* Naya Prokash.
23	Mohanan, C. N., & Nair, C. T. S. (2003). *Plant resources of Kerala: Medicinal and aromatic plants.* KFRI Handbook No. 15.
24	Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature, 403*(6772), 853–858.
25	Nayar, T. S. (1997). *Flora of Kerala: Analysis.* Botanical Survey of India.
26	Nayar, T. S., Beegam, A. R., & Mohanan, N. (2014). *Flowering plants of Kerala: A handbook*. TBGRI.
27	Pascal, J. P. (1988). *Wet evergreen forests of the Western Ghats of India: Ecology, structure, floristic composition and succession.* Institut Français de Pondichéry.
28	Prasad, S. N., Ramachandra, T. V., & Subramanian, D. K. (2002). Vegetation mapping of the Western Ghats using satellite remote sensing data. *Current Science, 83*(10), 1232–1238.
29	Radhakrishnan, C., & Nair, M. V. (2007). *Biodiversity of Kerala*. Kerala Forest Research Institute.
30	Rodgers, W. A., & Panwar, H. S. (1988). *Biogeographical classification of India*. Wildlife Institute of India.
31	Sukumaran, S., & Jeeva, S. (2008). *Sacred groves of Kerala: A repository of endemic flora*. *Indian Journal of Traditional Knowledge*, 7(3), 426–429.
32	WWF India. (2018). *Western Ghats biodiversity hotspot: Conservation strategies*. WWF–India.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visit	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Study reports on north Kerala.	5

•	Internal Practical Examination	10

Employability for the Course / Programme

Student on successful completion will be best suited for the research as well as jobs on Environmental science, comparative ecology and Ecosystem modelling.

33	Applications of Botany in Industries - North Kerala		KU8DSCPLS408
DSC	Semester: 8	Hrs/week: 3 Theory + 1 PRACTICAL	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Identify and describe key plant species and their industrial uses in Kerala.
CO2	Demonstrate knowledge of processing, preservation, and quality assessment of timber, bamboo, fibers, dyes, and spices.
CO3	Evaluate industrial products for compliance with quality, safety, and sustainability standards.
CO4	Integrate botanical and industrial knowledge to suggest innovations in plant-based products and bioproducts.
CO5	Prepare project proposals or operational plans for plant-based industrial enterprises.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						

CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course is an inducing course designed for the undergraduates
• *First module explores Kerala's timber resources, including teak and rosewood, and the softwoods commonly used in plywood and furniture.* • *Focus on plant fibers (cotton, coir, banana fiber, sisal) and their industrial processing, coir industry practices, natural dyes, and bamboo/rattan treatment for furniture and handicrafts will be gathered by the learning of the second module.* • *Third module covers spice and essential oil processing, medicinal plant-based industries, agro-processing of food products, and plant biopolymers.* • *The final module Introduces floriculture, plant-based cosmetics, eco-tourism, and industrial quality assurance.*
By the completion of this course students will be equipped to work in research and development, sustainable product design, and consultancy in botanical and industrial applications.

Course Objectives:

1. Understand major plant-based industries in Kerala, including timber, bamboo, fiber, spice, and medicinal plant industries.
2. Learn processing methods, treatment procedures, and quality control standards for industrial plant products.
3. Examine the economic, ecological, and sustainability implications of plant resource utilization.
4. Apply analytical and phytochemical techniques to assess plant-based products.
5. Explore research and innovation opportunities in plant-based industrial products and value addition.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 2 (45+ 0 + 30)	5	35	65	100

COURSE CONTENT

Module 1: Timber and Wood-based Industries 12 Hrs

1.1. Plywood and Timber Industry: Major timber species in Kerala: Timbers: Teak (*Tectona grandis*)and Rosewood (*Dalbergia latifolia*). Major Soft woods of the area and their uses. Basic procedures: log selection, seasoning, veneer preparation, lamination, bonding techniques, Grades of plywood: commercial, marine, and decorative grades. Quality control: moisture content, bonding strength, warping, fungal resistance.

1.2. Rubber-based Industry: Rubber (*Hevea brasiliensis*). Rubber extraction and processing: latex collection, coagulation, crepe, smoked sheets. Industrial applications: gloves, footwear, adhesives, rubber wood furniture. Grades of rubber: TSR (Technically Specified Rubber), latex grades, crepe grades. Quality checking: dry rubber content, ash content, tensile strength, color index

1.3. Paper and Pulp Industry: Raw material: bamboo, eucalyptus, bagasse, rubberwood residues. Basic processes: pulping (chemical and mechanical), bleaching, paper formation,

finishing. Paper grades: writing, printing, packaging, specialty papers. Quality control: fiber length, grammage, opacity, tensile strength, whiteness index 1.4. Wood Preservation and Value Addition: Preservation methods: chemical treatments, pressure treatment, fire retardants. Wood-based bioproducts: veneers, laminates, particle boards. Research focus: development of eco-friendly preservatives, bamboo composites
Module 2: Bamboo, Fibre and Dye based industries 12 hrs 2.1. Plant Fibers and Textiles: Cotton (Gossypium spp.), coir (Cocos nucifera), banana fiber (Musa spp.), sisal (Agave sisalana). Fiber processing: retting, decortication, spinning, weaving, finishing. Grades: long staple, short staple, coir mats, coir yarns. Quality checking: fiber strength, fineness, moisture content, color uniformity. 2.2. Coir Industry in Kerala: Production chain: husk collection, retting, fiber extraction, spinning, mat and rope making. Industrial products: mattresses, ropes, brushes, geotextiles. Research areas: enhancing fiber yield, eco-friendly retting methods, mechanical processing innovations. 2. 3. Natural Dyes and Pigments: Dye-yielding plants: Indigofera tinctoria, Curcuma longa, Bixa Orellana. Extraction procedures: aqueous, solvent, enzymatic methods. Applications: textile dyeing, food coloring, cosmetic formulations. Quality checking: color fastness, pH stability, concentration, purity. 2.4.Bamboo rattan: Bamboo and rattan for handicrafts, construction, and furniture. Sun/ Kiln drying, chemical, mechanical and temperature treatments for seasoning, preservation and coating.
Module 3: Agro-based and Phytochemical Industries 12 hrs 3.1. Spice and Essential Oil Industry: Major spices of Kerala: black pepper, cardamom, clove, cinnamon, nutmeg. Basic procedures: harvesting, drying, extraction, distillation, packaging. Grades of spice products: whole, powdered, essential oil grades. Quality checking: volatile oil content, moisture, microbial contamination, adulteration detection. 3.2. Medicinal Plant-based Industries: Plants: *Acorus calamus, Nothapodytes nimmoniana, Rauvolfia serpentina, Curcuma longa.* Products: herbal extracts, decoctions, essential oils, nutraceuticals. Basic procedures: drying, extraction, formulation, standardization. Quality control: phytochemical profiling, HPLC/GC analysis, microbial testing 3.3. Agro-processing and Food Industry: Plant-derived products: coconut oil, cashew nut, tamarind, banana chips. Industrial processes: cleaning, drying, extraction, packaging. Grades: edible oils, snack grades, pulp/puree standards. Quality checking: moisture content, oil content, free fatty acid %, microbial safety 3.4. Plant Biopolymers and Biochemicals: Starch, cellulose, gums, resins (e.g., cashew nut shell liquid). Applications in adhesives, coatings, biodegradable plastics. Research focus: optimization of extraction, functional modification, industrial scale-up.
Module 4. Industrial Applications of Floristic and Ornamental Plants (12 hrs) 4.1. Floriculture and Ornamental Plants Industry: Cut flowers: orchids, anthuriums, hibiscus. Landscape plants for urban and resort horticulture. Basic procedures: propagation, nursery management, post-harvest handling. Grades: cut flower quality, potted plant standards, foliage grading 4.2. Plant-based Cosmetics and Fragrance Industry: Plants: vetiver (Chrysopogon zizanioides), sandalwood (Santalum album), rose (Rosa spp.). Procedures: essential oil extraction, formulation, packaging. Grades: cosmetic grade oils, perfumes, therapeutic oils. Quality checking: GC-MS analysis, purity, shelf-life stability. . 4.3. Eco-tourism and Floristic Resource Utilization: Botanical gardens, spice gardens, medicinal plant parks, herbal trails. Sustainable plant harvesting for tourism and education. 4.4. Industrial Quality Assurance and Standards: International and national standards: ISO, BIS, FSSAI. Analytical techniques: HPLC, GC-MS, spectrophotometry, microscopy.

Product certification and traceability.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5Hrs** Small scale industries. Mushroom cultivation and value addition. Mushroom pellett production. Live feed culture. Microgreen production. Cattle feed making. Starch powder from Arrowroot. Apiculture. **Practical 10 Hrs** 1. Visit to industries and internship for 5 days. Make a report and it will be used for practical evaluation along with viva and presentation. 2. Starch production from various sources 3. Powder adulteration techniques

Suggested Assignment Topics- Theory

1. Methods for various extractions
2. Coconut based industries
3. Musa based industries
4. Food processing industry

Suggested Assignment Topics- Practical

1. Mushroom cultivation
2. Mushroom spawn production
3. Spice and condiment production
4. Curry powder adulteration checking.

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	"Bondex Bamboo Care: Clear Protection for Outdoor Bamboo." (2024). Bondex Wood Protection. Retrieved from https://bondexwood.com/products/wood-protection/bondex-bamboo-care.html
2	Ahmad, S., & Sharma, R. (2018). *Processing and utilization of medicinal plants in India.* New Delhi: Springer.
3	Anon. (2023). Bamboo and rattan treatment for furniture and handicrafts. Retrieved from https://www.fao.org/bamboo-rattan
4	Arora, R. K., & Nayar, T. S. (1999). *Plant resources of India: Fiber and dye plants.* New Delhi: Botanical Survey of India.
5	Bhattacharya, S. (2017). *Industrial applications of spices and essential oils.* Woodhead Publishing.
6	Bose, T. K., & Som, M. G. (2001). *Commercial flowers.* Kolkata: Naya Prokash.
7	Branden, C., & Tooze, J. (2012). *Introduction to protein structure.* Garland Science.
8	Chandrasekharan, S. (2015). Rubberwood: Processing and utilization in India. *Journal of Wood Science, 61*(2), 153-162.
9	Chopra, R. N., Nayar, S. L., & Chopra, I. C. (1956). *Glossary of Indian medicinal plants.* CSIR, India.
10	Das, S., & Nair, M. (2018). Sustainable bamboo furniture: Techniques and industrial relevance. *Journal of Bamboo and Rattan, 17*(1), 25-40.
11	FAO. (2020). *Non-wood forest products: Bamboo and rattan.* Rome: FAO.
12	Gopalan, P., & Nair, S. C. (2011). *Vegetation and biodiversity of the Western Ghats of Kerala.* Kerala Forest Research Institute.
13	Henry, A. N., Kumari, G. R., & Chithra, V. (1987). *Flora of Kerala (Vols. 1–3).* Botanical Survey of India.
14	Indian Council of Forestry Research and Education (ICFRE). (2023). *State of non-timber forest*

	products in India: Focus on bamboo & rattan.
15	Kapoor, I., & Singh, M. (2016). Advances in coir processing and industrial applications. *Journal of Natural Fibers, 13*(3), 327-339.
16	Kumar, A., & Singh, R. (2019). Plant-based natural dyes: Extraction, applications, and eco-friendly processing. *Dyeing & Textile Journal, 45*(2), 77-92.
17	Menon, S. (2002). *Ecology and conservation of tropical rain forests in India.* Naya Prokash.
18	National Design & Research Forum. (2020). *Sustainable furniture design with bamboo & rattan.* NID Publication.
19	Nayar, T. S., Beegam, A. R., & Mohanan, N. (2014). *Flowering plants of Kerala: A handbook.* Tropical Botanical Garden & Research Institute.
20	Paschapal, J. P. (1988). *Wet evergreen forests of the Western Ghats of India.* Pondicherry: Institut Français de Pondichéry.
21	Prasad, S. N., Ramachandra, T. V., & Subramanian, D. K. (2002). Vegetation mapping of the Western Ghats using satellite remote sensing data. *Current Science, 83*(10), 1232-1238.
22	Radhakrishnan, C., & Nair, M. V. (2007). *Biodiversity of Kerala.* Kerala Forest Research Institute.
23	Ramesh, S., & Sivakumar, K. (2019). Mechanical properties of treated rattan poles for furniture. *Indian Journal of Forest & Furniture Science, 10*(1), 52-60.
24	Sharma, T., & Miao, L. (2021). Bamboo weaving in modern furniture: Materials, treatments, and design trends. *BioResources, 16*(2), 2894-2906.
25	Singh, H., & Gupta, A. (2018). Comparative analysis of heat vs chemical treatment of bamboo. *Wood Material Science & Engineering, 13*(3), 135-145.
26	Tewari, D. N. (2000). *Bamboo preservation.* Forest Research Institute, India.
27	Thomas, S., & Ravindran, P. (2016). Treatment of rattan furniture: Preservation, mechanical performance, and finish. *International Journal of Furniture Science, 12*(4), 280-289.
28	Van der Veen, M. (2015). *Biopolymers from plant resources: Applications and industrial relevance.* Woodhead Publishing.
29	World Bank. (2017). *Enhancing forest-based value chains: The case of bamboo furniture in India.* World Bank Report.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visit	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal PracticalExamination	10

Employability for the Course / Programme

Students completing this course will be prepared for careers in plant-based industrial sectors.

34	Advanced course in Angiosperm Systematics		KU8DSEPLS409
DSE	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Differentiate between major historical and phylogenetic classification systems and their modern relevance.
CO2	Apply international nomenclatural codes (ICBN & ICNCP) in naming and describing taxa.
CO3	Analyze molecular sequence data to infer phylogenetic relationships among disputed angiosperm families.
CO4	Perform DNA barcoding and interpret molecular phylogenies for species identification.
CO5	Develop digital herbarium specimens and integrate SEM/TEM morphological data for systematic studies.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						

CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course provides an advanced understanding of the principles, methods, and modern protocols in angiosperm systematics, integrating molecular phylogenetics, DNA barcoding, and digital herbarium technologies to resolve taxonomic controversies and elucidate evolutionary relationships.

- *First module analyzes classical and modern classification systems, nomenclatural codes, hybrid/cultivar rules, and taxonomic controversies in major angiosperm families.*
- *Second module focuses on the molecular foundations of angiosperm systematics by exploring nuclear, plastid, and mitochondrial markers, and illustrates how molecular data resolved long-standing disputes in key plant families.*
- *Third module provides hands-on theoretical understanding of DNA barcoding and molecular phylogenetics — from gene selection and sequencing to phylogenetic tree construction and species delimitation.*
- *Fourth module examines ultrastructural taxonomy through SEM and TEM, and demonstrates digital herbarium development and morphological character coding as tools in integrative and data-driven systematics.*

This course will provide you opportunities to see the merging of two knowledge rivers namely angiosperm systematics and bioinformatics.

Course Objectives:

1. Comprehend and critically evaluate classical and modern systems of angiosperm classification.
2. Understand and apply the rules and procedures of botanical nomenclature and cultivar registration.
3. Identify key molecular markers and genomic regions used in resolving taxonomic and phylogenetic disputes.
4. Execute laboratory-level molecular systematics techniques including DNA barcoding, sequencing, and phylogenetic reconstruction.
5. Integrate advanced morphological, ultrastructural, and digital documentation methods for comprehensive taxonomic analysis..

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (6+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Classification, Nomenclature, and Historical Debates 12 hrs

1.1 Natural system of classification: Engler and Prantl (1915) . Comparison with Bentham & Hookers and APG IV. Strengths and limitations.

1.2.Phylogenetic system of classification: Hutchinson (1973): Comparison with Bentham & Hookers and APG IV. Strengths and limitations.

1.3.International Code of Botanical Nomenclature (ICBN): Rules for naming species, priority, typification, valid publication, conservation of names. Nomenclature of Hybrids and Cultivars: Interspecific hybrids, intergeneric hybrids, cultivar registration, International Code of Nomenclature for Cultivated Plants (ICNCP). 1.4.Taxonomic Controversies: Major Controversies in systematics- Inclusion and exclusion into a taxa; Subdivision of taxa. Controversy on valid name, etc.. Need of integrating molecular, morphological, and biogeographical evidence to resolve disputes.
Module 2: Major genes and genomes used for solving of disputes 12 hrs 2.1. Nuclear DNA markers: rDNA (ribosomal DNA)-18S rDNA, 26S rDNA, ITS (Internal Transcribed Spacer) regions. Low-copy nuclear genes: Genes like PHYC, GBSSI (waxy), NIA. 2.2. Plastid (chloroplast) DNA markers: Coding regions - rbcL (large subunit of RuBisCO); matK (maturase K); ndhF, atpB, petD; Non-coding regions- trnL-F intergenic spacer, psbA-trnH, etc. 2. 3. Mitochondrial DNA and Whole plastid genomes (plastomes) 2.4. Major solved controversies: 1. Acantahceae- Varbenaceae-Lamiaceae. 2, Malvaceae-Sterculiaceae-Tiliaceae- Bombacaceae. 3. Scrophulariaceae. 4. Euphorbiaceae
Module 3: Molecular Systematics and DNA Barcoding 12 hrs 3.1. DNA Barcoding Principles and Protocols: Gene regions (rbcL, matK, ITS), selection of primers, universality, pros and cons. 3.2. Laboratory Workflow: Sample collection, DNA extraction, PCR, sequencing, gel electrophoresis, quality assessment. 3.3. Phylogenetic Analysis: Sequence alignment, NJ, ML, Bayesian inference, barcode gap analysis, resolving cryptic species. 3.4. Applications and Case Studies: Identifying endangered, endemic, and economically important species; resolving taxonomic ambiguities and solving controversies.
Module 4. Advanced Morphology and Digital Herbarium 12 hrs 4.1. SEM and TEM in Angiosperm Taxonomy: Pollen ultrastructure, trichomes, stomata, seed coat morphology, vascular patterns. 4.2. Digital Herbarium Development: Imaging standards, metadata curation, software platforms (Symbiota, JSTOR Plants), online access. 4.3. Morphological Character Coding for Phylogenetics: Quantitative and qualitative characters for cladistic analysis. 4.4. Integrative Taxonomy: Combining SEM/TEM, molecular, and digital herbarium data for species delimitation and identification.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 2Hrs** Collection of more original papers and reading on the use of molecular data in angiosperm systematics. **Practical 10 Hrs** 1. Revisiting the controversial genera for morphological characters 2. Preparation of herbaria of controversial taxa 3. Exhibition of herbaria and live plant of controversy to the juniors to create a taxonomic enthusiasm 4. Searching for the varying sequences in databases. 5. Searching for co-evolution related data in molecular databases 6. Visit Symbiota and JSTOR plants platforms.

Suggested Assignment Topics- Theory

1. Protocol for analysing pollen under SEM and TEM
2. Various microscopic techniques used in taxonomy
3. Microscopic features relevant in Angiosperm taxonomy

Suggested Assignment Topics- Practical

1. Palynology of controversial genera for comparison
2. Structural elucidation of various proteins in the controversial genera

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	APG IV. (2016). An update of the Angiosperm Phylogeny Group classification. *Botanical Journal of the Linnean Society, 181*(1), 1–20.
2	Bentham, G., & Hooker, J. D. (1862–1883). *Genera Plantarum* (Vols. 1–3). London: Reeve & Co.
3	Chase, M. W., & Reveal, J. L. (2009). A phylogenetic classification of the land plants. *Taxon, 58*(3), 591–601.
4	Cronquist, A. (1981). *An integrated system of classification of flowering plants.* New York: Columbia University Press.
5	Davis, P. H., & Heywood, V. H. (1963). *Principles of angiosperm taxonomy.* Edinburgh: Oliver & Boyd.
6	Engler, A., & Prantl, K. (1887–1915). *Die Natürlichen Pflanzenfamilien.* Leipzig: Engelmann.
7	Hutchinson, J. (1973). *The families of flowering plants* (3rd ed.). Oxford: Clarendon Press.
8	Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). *Plant systematics: A phylogenetic approach* (4th ed.). Sunderland, MA: Sinauer Associates.
9	Simpson, M. G. (2019). *Plant systematics* (3rd ed.). Academic Press.
10	Takhtajan, A. (1997). *Diversity and classification of flowering plants.* New York: Columbia University Press.
11	Chase, M. W., Fay, M. F., & Savolainen, V. (2000). Higher-level classification in the Angiosperms. *American Journal of Botany, 87*(12), 1759–1776.
12	Cantino, P. D., Harley, R. M., & Wagstaff, S. J. (1992). Relationships within the Lamiaceae and Verbenaceae. *Annals of the Missouri Botanical Garden, 79*(2), 361–379.
13	Scotland, R. W., Olmstead, R. G., & Bennett, J. R. (2003). Phylogeny reconstruction: The role of morphology. *Systematic Biology, 52*(4), 539–548.
14	Soltis, D. E., Soltis, P. S., Endress, P. K., & Chase, M. W. (2005). *Phylogeny and evolution of angiosperms.* Sunderland, MA: Sinauer Associates.
15	Stevens, P. F. (2001 onward). *Angiosperm Phylogeny Website, version 14, July 2017.* Missouri Botanical Garden. http://www.mobot.org/MOBOT/research/APweb/
16	Thorne, R. F. (1992). Classification and geography of the flowering plants. *Botanical Review, 58*(3), 225–348.
17	Wurdack, K. J., & Davis, C. C. (2009). Malpighiales phylogeny: Plastid and nuclear data integration. *American Journal of Botany, 96*(11), 2010–2021.
18	Olmstead, R. G., dePamphilis, C. W., Wolfe, A. D., Young, N. D., Elisons, W. J., & Reeves, P. A. (2001). Disintegration of the Scrophulariaceae. *American Journal of Botany, 88*(2), 348–361.
19	Chase, M. W., & Hills, H. H. (1991). Silica gel: An ideal material for field preservation of leaf samples for DNA studies. *Taxon, 40*(2), 215–220.
20	Fay, M. F., Swensen, S. M., & Chase, M. W. (1997). rbcL sequence data for angiosperms. *Annals of the Missouri Botanical Garden, 84*(1), 1–49.*
21	CBOL Plant Working Group. (2009). A DNA barcode for land plants. *Proceedings of the National Academy of Sciences, 106*(31), 12794–12797.

22	Hollingsworth, P. M., Forrest, L. L., Spouge, J. L., Hajibabaei, M., Ratnasingham, S., & van der Bank, M. (2009). A DNA barcode for land plants. *PNAS, 106*(31), 12794–12797.
23	Hebert, P. D. N., Cywinska, A., & Ball, S. L. (2003). Biological identifications through DNA barcodes. *Proceedings of the Royal Society B, 270*(1512), 313–321.
24	Kress, W. J., & Erickson, D. L. (2007). A two-locus global DNA barcode for land plants: rbcL and matK. *PLoS ONE, 2*(6), e508.
25	Doyle, J. J., & Doyle, J. L. (1987). A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bulletin, 19*(1), 11–15.
26	Katoh, K., & Standley, D. M. (2013). MAFFT multiple sequence alignment software version 7. *Molecular Biology and Evolution, 30*(4), 772–780.
27 28 29 30	Ronquist, F., Teslenko, M., van der Mark, P., et al. (2012). MrBayes 3.2: Efficient Bayesian phylogenetic inference. *Systematic Biology, 61*(3), 539–542. Stamatakis, A. (2014). RAxML version 8: A tool for phylogenetic analysis. *Bioinformatics, 30*(9), 1312–1313.* Missouri Botanical Garden. (2024). *Tropicos Plant Database.* https://www.tropicos.org International Association for Plant Taxonomy (IAPT). (2018). *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code).* https://www.iapt-taxon.org/nomen/main.php

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Online bioinformatics databases	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal Practical Examination/ exhibition	10

Employability for the Course / Programme

This course equips learners with advanced taxonomic, molecular, and data management skills applicable in biodiversity research, molecular taxonomy laboratories, botanical gardens, herbaria, and conservation genetics programs.

35	Plant Microtechnique		KU8DSEPLS410
DSE	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:
1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the principles and procedures of various microtechniques used in botany.
CO2	Prepare high-quality permanent and temporary slides of plant materials.
CO3	Operate and maintain compound, phase contrast, fluorescence, and electron microscopes.
CO4	Apply appropriate staining techniques to distinguish plant cell and tissue structures.
CO5	Integrate modern microscopic imaging and digital analysis tools in botanical investigations

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course provides a hands-on and theoretical understanding of the preparation, sectioning, staining, and microscopic analysis of plant tissues—from algae to angiosperms—using both traditional and modern microtechniques.
• *First module introduces the fundamentals of microscopy and specimen preparation, establishing a conceptual foundation for microscopic analysis in botany.* • *Second module is dealing with sample preservation and sectioning methods crucial for anatomical and cytological studies of plant tissues.* • *Third module explores differential staining procedures that reveal structural and functional details across algal, fungal, bryophytic, pteridophytic, gymnospermic, and angiospermic tissues.* • *The final module integrates modern microscopy and imaging technologies with traditional microtechnique to support advanced botanical research..*
This course will provide you opportunities to get a hands on training in plant microtechnique.

Course Objectives:

1. To provide a conceptual and practical understanding of microtechnique and its significance in plant studies.
2. To train students in the preparation of plant specimens using modern fixation, dehydration, embedding, and sectioning methods.
3. To familiarize students with various types of light and electron microscopes and their operational principles.
4. To impart skills in differential staining techniques across plant groups—from lower to higher plants.
5. To enhance competency in modern microscopic imaging, analysis, and interpretation for research and industry applications.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Introduction to Microtechnique and Microscopy (12 Hours)
1.1.History, scope, and importance of microtechnique in plant research. 1.2.Principles, components, and maintenance of different types of microscopes (light, phase contrast, fluorescence, confocal, SEM, TEM). 1.3.Resolution, magnification, contrast, and digital imaging systems. 1.4.Preparation and mounting of temporary slides; safety and laboratory protocols.
Module 2: Fixation, Dehydration, Embedding, and Sectioning Techniques (10 Hours)
2.1.Fixatives: types, preparation, and mechanism of fixation (FAA, Carnoy's, formalin-based fixatives). 2.2.Dehydration and clearing agents: alcohol series, xylene, DMP, etc. 2.3.Embedding media and techniques: paraffin wax, resin, and cryoembedding. 2.4.Microtome techniques: rotary, sliding, sledge, ultramicrotome—principles and operation
Module 3: Staining Techniques in Lower to Higher Plants (14 Hours)

3.1.Staining principles: single, double, and multiple stains; mordants and differentiators. 3.2.Staining of lower plants: algal (aniline blue, safranin), fungal (cotton blue, lactophenol), bryophytes. 3.3.Staining of vascular plants: safranin–fast green, hematoxylin–eosin, toluidine blue O, PAS reaction. 3.4.Cytochemical and histochemical localization: lignin, suberin, starch, proteins, and nucleic acids..
Module 4. Modern Microtechnique and Digital Imaging in Botany (12 Hours) 4.1.Confocal and fluorescence microscopy in plant cell imaging. 4.2.Scanning and transmission electron microscopy: sample preparation and image interpretation. 4.3.Digital image processing, 3D reconstruction, and quantitative analysis of tissues. 4.4.Applications in taxonomy, physiology, plant pathology, and biotechnology.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Practical 12 Hrs** 1. Study of the parts, principles, and operation of different microscopes (compound, phase contrast, stereo). 2. Preparation and mounting of temporary slides of algal and fungal specimens. 3. Preparation and use of common botanical fixatives (FAA, Carnoy's, Formalin). 4. Dehydration and clearing of plant tissues using graded alcohol and clearing agents. 5. Paraffin embedding and preparation of tissue blocks for microtomy. 6. Operation of rotary and sliding microtomes and preparation of thin tissue sections. 7. Staining of lower plants – algae, fungi, and bryophytes using specific stains (aniline blue, cotton blue, safranin). 8. Differential staining of higher plant tissues (safranin–fast green, toluidine blue, etc.). 9. Cytochemical localization of cellular compounds (starch, lignin, suberin, proteins). 10. Preparation and mounting of permanent botanical slides using DPX or Canada balsam. 11. Observation of plant cell structures using fluorescence microscopy. 12. Demonstration of confocal laser scanning microscopy for plant tissue imaging. 13. Demonstration of scanning electron microscopy (SEM) for plant surface studies. 14. Demonstration of transmission electron microscopy (TEM) for cellular ultrastructure. 15. Digital image capture and processing using microscopy software (e.g., ImageJ) and preparation of histological reports

Suggested Assignment Topics- Theory

1. Protocols for various specialised structures such as pollen, spores, etc
2. Pathogen identification using specific stains

Suggested Assignment Topics- Practical

1. Whole mounts of algal filaments
2. Spore germination of bryophyte /pteridophytes
3. Palynology

l. No	**Title/Author/Publishers of the Book specific to the module**

1	Bary, A., & Smith, J. (2019). Plant Microtechnique: Principles and Practices. Springer.
2	Berlyn, G. P., & Miksche, J. P. (1976). Botanical Microtechnique and Cytochemistry. Iowa State University Press.
3	Bozzola, J. J., & Russell, L. D. (1999). Electron Microscopy: Principles and Techniques for Biologists. Jones & Bartlett.
4	Brown, R. C., & Lemmon, B. E. (2013). Light and Electron Microscopy of Plant Cells. Academic Press.
5	Conn, H. J. (1961). Biological Stains: A Handbook on the Nature and Uses of the Dyes Employed in the Biological Laboratory. Williams & Wilkins.
6	Dey, P. (2018). Basic and Advanced Laboratory Techniques in Histopathology and Cytology. Springer.
7	Erasmus, D. J. (2020). Histological Techniques for Plant Tissues. Cambridge University Press.
8	Hall, J. L. (1978). Electron Microscopy and Cytochemistry of Plant Cells. Elsevier.
9	Jensen, W. A. (1962). Botanical Histochemistry: Principles and Practice. W. H. Freeman.
10	Johansen, D. A. (1940). Plant Microtechnique. McGraw-Hill.
11	Kraus, J. E., & Arduin, M. (1997). Manual Básico de Métodos em Morfologia Vegetal. EDUR.
12	Lee, J. W., & Lim, C. (2021). Digital Microscopy in Life Sciences. CRC Press.
13	O'Brien, T. P., & McCully, M. E. (1981). The Study of Plant Structure: Principles and Selected Methods. Termarcarphi Pty Ltd.
14	Pathan, A. K., Bond, J., & Gaskin, R. E. (2008). Sample preparation for SEM of plant surfaces. Micron, 39(8), 1049–1061.
15	Ruzin, S. E. (1999). Plant Microtechnique and Microscopy. Oxford University Press.
16	Sass, J. E. (1958). Botanical Microtechnique. Iowa State University Press.
17	Steer, M. W. (1981). Understanding Cell Structure: A Practical Guide to the Light Microscope. Cambridge University Press.
18	Watanabe, M. (2016). Advanced Fluorescence Microscopy for Plant Science. Springer.
19	Yeung, E. C., & Stasolla, C. (2017). Plant Microtechniques and Protocols. Springer Protocols.
20	Zimmerman, U. (2018). Modern Microscopy Techniques in Plant Biology. Elsevier.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the	5

students	
• Internal Practical Examination	10

Employability for the Course / Programme

This course equips students with essential laboratory and analytical skills relevant to careers in plant histology, taxonomy, pathology, biotechnology, environmental monitoring, and research laboratories.

36	Nanobiotechnology		KU8DSEPLS411
DSE	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the basic principles, terminology, and scope of nanobiotechnology.
CO2	Identify naturally occurring nanoparticles and distinguish nanoscale features from bulk materials.
CO3	Describe various physical, chemical, and biological synthesis methods for nanoparticles.
CO4	Demonstrate understanding of nanobiotechnological applications in plant systems and environmental sustainability.
CO5	Apply laboratory skills for green nanoparticle synthesis, characterization, and basic evaluation of biological activity.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	

CO5									√	√	√	√

Course Description
Nanobiotechnology is an emerging interdisciplinary field that merges nanoscience with biological systems to explore and manipulate materials at the nanoscale.
• *First module introduces the foundation and evolution of nanoscience, emphasizing its relevance in plant and biological systems.* • *Next module focuses on the principles and methods of nanoparticle synthesis, with an emphasis on eco-friendly and biological approaches.* • *Third module explores how nanobiotechnology can revolutionize various branches of botany, from plant growth to environmental applications.* • *The final module examines nanobiosensors, their applications, and the biosafety regulations governing nanomaterial use.*
This course provides a foundation in the principles, synthesis, and applications of nanomaterials in biological contexts, emphasizing green synthesis, biosafety, and environmental implications.

Course Objectives:

1. To introduce the fundamental concepts of nanoscience and nanotechnology with relevance to plant systems.
2. To explore the natural occurrence and synthesis methods of nanoparticles.
3. To provide understanding of the physicochemical and biological properties of nanoparticles.
4. To familiarize students with the applications of nanobiotechnology in agriculture, environment, and plant sciences.
5. To develop awareness of biosafety, ethics, and environmental implications of nanomaterial use.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Introduction and Historical Perspective of Nanobiotechnology (12 Hours)
1.1.Historical development of nanoscience and nanobiotechnology; key milestones. 1.2.Definition, scope, and interdisciplinary nature of nanotechnology and nanobiotechnology. 1.3.Unique features and properties of nanoparticles; changes in physical and chemical characteristics from bulk to nano scale. 1.4.Naturally occurring nanoparticles in plants, soils, and microorganisms (e.g., diatoms, magnetotactic bacteria, pollen structures).
Module 2: Synthesis and Characterization of Nanoparticles (10 Hours)
2.1.Top-down and bottom-up approaches; overview of synthesis methods. 2.2.Physical and chemical methods: laser ablation, sol–gel, co-precipitation, and microemulsion techniques.

2.3.Green synthesis: nanoparticle production using plant extracts, algae, fungi, and bacteria. 2.4.Characterization techniques: UV-Vis spectroscopy, SEM, TEM, XRD, FTIR, and DLS (qualitative overview).
Module 3: Applications of Nanobiotechnology in Plant Science 3.1. Nanoparticles in seed germination, growth enhancement, and stress tolerance. 3.2.Nanofertilizers and nanopesticides: controlled release and sustainable agriculture. 3.3.Nanobiotechnology in plant tissue culture, genetic transformation, and molecular diagnostics. 3.4.Environmental applications: phytoremediation, water purification, and carbon sequestration using nanomaterials.
Module 4. Nanobiosensors, Safety, and Ethical Issues (12 Hours) 4.1. Principles and design of nanobiosensors for detecting toxins, pathogens, and environmental pollutants. 4.2.Applications of nanobiosensors in agriculture, food quality monitoring, and plant disease diagnostics. 4.3.Safety, toxicity, and ethical concerns of nanoparticles in biological systems. 4.4.National and international guidelines for handling, storage, and disposal of nanomaterials.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 2Hrs** Nanobiotechnology, nanomedicine and nanosensors for human medical care **Practical 10 Hrs** 1. Nanoparticle isolation 2. Characterisation of nano particles 3. Sunscreen and UV protection using UV papers/beads 4. Magnetism and ferrofluid

Suggested Assignment Topics- Theory

1. Uses of nanotechnology in medicine
2. Nanotechnology in cosmetics
3. Drug targeted delivery
4. Site specific druge delivery

Suggested Assignment Topics- Practical

1. Nanoparticle isolation from leaves

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bhattacharya, D., Gupta, R. K. (2005). *Nanotechnology and Potential of Microorganisms.* Critical Reviews in Biotechnology, 25(4), 199–204.
2	Ratner, M. A., & Ratner, D. (2003). *Nanotechnology: A Gentle Introduction to the Next Big Idea.* Prentice Hall.
3	Goodsell, D. S. (2004). *Bionanotechnology: Lessons from Nature.* Wiley-Liss.
4	Ramsden, J. J. (2016). *Nanotechnology: An Introduction.* Elsevier.
5	Buzea, C., Pacheco, I. I., & Robbie, K. (2007). *Nanomaterials and Nanoparticles: Sources and Toxicity.* Biointerphases, 2(4), MR17–MR71.
6	Daniel, M. C., & Astruc, D. (2004). *Gold Nanoparticles: Assembly, Supramolecular Chemistry, Quantum-Size-Related Properties, and Applications Toward Biology.* Chemical Reviews, 104(1), 293–346.

7	Nel, A., et al. (2006). *Toxic Potential of Materials at the Nanolevel.* Science, 311(5761), 622–627.
8	Singh, A., & Dhawan, A. (2019). *Nanotechnology in Agriculture and Food Production: Opportunities and Challenges.* CABI Publishing.
9	Rai, M., & Duran, N. (Eds.). (2011). *Metal Nanoparticles in Microbiology.* Springer.
10	Roco, M. C., & Bainbridge, W. S. (2005). *Societal Implications of Nanoscience and Nanotechnology.* Springer.
11	Jain, K. K. (2012). *The Handbook of Nanomedicine.* Humana Press.
12	Mukherjee, P., et al. (2001). *Fungus-Mediated Synthesis of Silver Nanoparticles and Their Immobilization in the Mycelial Matrix: A Novel Biological Approach to Nanoparticle Synthesis.* Nano Letters, 1(10), 515–519.
13	Sharma, V. K., Yngard, R. A., & Lin, Y. (2009). *Silver Nanoparticles: Green Synthesis and Their Antimicrobial Activities.* Advances in Colloid and Interface Science, 145(1–2), 83–96.
14	Sarkar, A., & Das, P. (2015). *Green Synthesis of Metal Nanoparticles Using Plant Extracts: A Review.* Environmental Chemistry Letters, 13, 315–328.
15	Goyal, A. K., & Tripathi, S. K. (2014). *Nanobiotechnology for Plant Protection and Productivity.* Biotechnology Letters, 36(4), 607–620.
16	Ghormade, V., Deshpande, M. V., & Paknikar, K. M. (2011). *Perspectives for Nanobiotechnology Enabled Protection and Nutrition of Plants.* Biotechnology Advances, 29(6), 792–803.
17	Kah, M., et al. (2018). *Nanopesticides and Nanofertilizers: Emerging Contaminants or Opportunities for Risk Mitigation?* Nature Nanotechnology, 13, 677–684.
18	Tiwari, D. K., Dasgupta-Schubert, N., Villaseñor-Cendejas, L. M., et al. (2014). *Interaction of Nanoparticles with Seeds and Plants: A Review.* Environmental Chemistry Letters, 12(2), 229–241.
19	Jain, K. K. (2013). *Nanobiotechnology: Applications, Ethics and Governance.* Springer.
20	Dey, P., & Mukherjee, A. (2020). *Nanotechnology in Plant Tissue Culture and Genetic Engineering.* In: *Plant Nanobionics: Principles and Applications.* Elsevier.
21	Sastry, R. K., Rao, N. H., & Ilyas, S. M. (2010). *Integrating Nanotechnology into Agri-Food Systems Research in India: A Conceptual Framework.* Technological Forecasting and Social Change, 77(4), 639–648.
22	Lynch, I., & Dawson, K. A. (2008). *Protein–Nanoparticle Interactions.* Nano Today, 3(1–2), 40–47.
23	ISO/TR 13121:2011. *Nanotechnologies — Nanomaterial Risk Evaluation.* International Organization for Standardization.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10

• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal Practical Examination	10

Employability for the Course / Programme

This course equips students with a strong interdisciplinary foundation combining nanoscience, biology, chemistry, and plant sciences, preparing them for careers and research opportunities in the rapidly evolving fields of biotechnology, agriculture, environment, and materials science.

37	Climate change and Disaster Management		KU8DSEPLS412
DSE	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the scientific basis and evidence for climate change and variability.
CO2	Assess the impacts of climate change on ecosystems, agriculture, and water resources.
CO3	Understands types, causes, and impacts of natural and anthropogenic disasters.
CO4	Evaluate the role of local, national, and international institutions in managing climate-induced disasters.
CO5	Formulate adaptation and mitigation strategies relevant to Kerala's socio-ecological context.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This is an inter disciplinary course designed for the undergraduate botanists to give an idea on climate change and disaster management.
• *First module is dealing with preliminary knowledge on Climate change and its basic principles.* • *Second module delves into the impacts and mitigation strategies on climate change.* • *Third module outlines the knowledge and perspectives of different types of disasters.* • *The last module contains the strategies and policies related to climate change and disaster management.*
This course will provide you opportunities to know the basics of climate change and disaster management.

Course Objectives:

1. To introduce the scientific principles underlying climate change and global environmental processes.
2. To familiarize students with the regional and global impacts of climate change on ecosystems, agriculture, and biodiversity.
3. To impart fundamental knowledge of disaster types, causes, and management strategies.
4. To develop awareness of climate resilience, adaptation, and mitigation approaches relevant to Kerala and India.
5. To understand institutional mechanisms, policy frameworks, and community-based disaster management strategies.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (60+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module I: Fundamentals of Climate Change *(12 hours)* 1.1 Introduction to Climate and Weather: Elements and factors controlling climate; difference between climate and weather; climate classification (Köppen's system). 1.2 Climate Change – Concepts and Causes: Definition, natural and anthropogenic causes; greenhouse effect, global warming, and feedback mechanisms. 1.3 Evidence and Indicators of Climate Change: Temperature trends, sea-level rise, glacial retreat, extreme weather events; data from IPCC reports. 1.4 Climate Systems and Global Circulation: Atmosphere–ocean interactions, El Niño–Southern Oscillation (ENSO), monsoon variability, and their influence on Indian climate.
Module 2: Impacts, Challenges, and Mitigation of Climate Change *(12 hours)* 2.1 Impacts on Ecosystems and Agriculture: Shifts in vegetation zones, phenological changes, soil degradation, and crop productivity; impacts on tropical vegetable systems of Kerala. 2.2 Water and Carbon Cycle Alterations: Evapotranspiration, precipitation patterns, and carbon sequestration changes under warming scenarios. 2.3 Socio-economic and Health Impacts: Food security, migration, vector-borne diseases,

livelihood challenges, and gender dimensions. 2.4 Climate Mitigation and Adaptation: Renewable energy, afforestation, carbon capture, sustainable agriculture; Kerala Climate Change Action Plan; role of local self-governments.
Module 3: Concepts and Types of Disasters *(12 hours)* 3.1 Introduction to Disaster Management: Definition, hazard–vulnerability–risk concepts, and disaster management cycle. 3.2 Types of Disasters: Natural: Floods, droughts, cyclones, landslides, coastal erosion, earthquakes. Human-induced: Industrial accidents, deforestation, epidemics, pollution, dam failures. 3.3 Disaster Risk Assessment: Hazard mapping, vulnerability analysis, early warning systems, and GIS applications. 3.4 Disaster Scenarios in Kerala: Case studies – 2018 Kerala floods, landslides in Wayanad and Idukki, coastal erosion and sea-level rise in Malabar coast.
Module 4: Strategies, Policies, and Institutions in Disaster Management *(12 hours)* 4.1 Disaster Preparedness and Response: Community-based disaster management (CBDM), early warning systems, mock drills, and emergency response planning. 4.2 Disaster Recovery and Rehabilitation: Post-disaster reconstruction, livelihood restoration, psychological and social rehabilitation. 4.3 Institutional Frameworks: NDMA, SDMA (Kerala State Disaster Management Authority), NDRF, UNDRR, IPCC, and international collaborations. 4.4 Sustainability and Climate Resilience: Integrated approaches linking climate adaptation with disaster management; ecosystem-based disaster risk reduction (Eco-DRR); role of education and media in awareness building.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 12 Hrs** **The Economic Dimensions of Climate Change:** Climate change as a market failure: externalities, public goods, and the tragedy of the commons. Cost–benefit analysis of mitigation and adaptation policies. Economic valuation of ecosystem services and climate damages (Stern Review, IPCC reports). **Political Economy of Climate Policy:** Power structures and political interests shaping climate policy. Role of fossil fuel lobbies, green movements, and international NGOs. Climate justice, equity, and environmental ethics. Climate diplomacy and geopolitics — China, India, and U.S. positions. Global South perspectives: adaptation funding, climate refugees, and developmental priorities **Contemporary Issues and Policy Instruments:** Carbon markets, taxes, and offset mechanisms (case study: Carbon pricing in the EU, India's renewable energy subsidies). Role of science, technology, and innovation in decarbonization. Emerging issues: Loss and damage debates, biodiversity–climate linkages, climate misinformation.

Suggested Assignment Topics- Theory

1. Climate change different views among scientists
2. Difference of opinion on Climate change among governments

Suggested Assignment Topics- Practical

1. Internship in NGOs/ Institutes working on Climate change
2. Debate in the class

Sl. No	**Title/Author/Publishers of the Book specific to the module**

1	Bryant, E. (2005). Natural Hazards. Cambridge University Press.
2	Cutter, S. L. (2012). Hazards, Vulnerability and Environmental Justice. Earthscan.
3	Dash, S. K. (2012). Climate Change: An Indian Perspective. Cambridge University Press.
4	Gupta, A. K., & Nair, S. S. (2011). Environmental Hazards: Assessment and Mitigation. Narosa Publishing House.
5	Gupta, J., & van der Grijp, N. (2010). *Mainstreaming climate change in development cooperation*. Cambridge University Press.
6	IPCC (2021). Sixth Assessment Report: Climate Change 2021 – The Physical Science Basis. Cambridge University Press.
7	IPCC. (2023). *Sixth Assessment Report (AR6): Synthesis Report*. Geneva: Intergovernmental Panel on Climate Change.
8	Keohane, R. O., & Victor, D. G. (2016). Cooperation and discord in global climate policy. *Nature Climate Change*, *6*(6), 570–575.
9	Klein, N. (2014). *This changes everything: Capitalism vs. the climate*. Simon & Schuster.
10	Ministry of Environment, Forest and Climate Change (MoEFCC). (2018). State Action Plan on Climate Change – Kerala. Government of Kerala.
11	NDMA (2019). National Disaster Management Plan. Government of India.
12	Newell, P., & Paterson, M. (2010). *Climate capitalism: Global warming and the transformation of the global economy*. Cambridge University Press.
13	Nordhaus, W. D. (2013). *The climate casino: Risk, uncertainty, and economics for a warming world*. Yale University Press.
14	Ostrom, E. (2009). A polycentric approach for coping with climate change. *World Bank Policy Research Paper No. 5095.*
15	Paterson, M. (2021). *Climate politics: Concepts and debates*. Polity Press.
16	Pelling, M. (2011). Adaptation to Climate Change: From Resilience to Transformation. Routledge.
17	Piketty, T., & Chancel, L. (2015). Carbon and inequality: From Kyoto to Paris. *Paris School of Economics Working Paper Series*.
18	Ramanathan, V. (2019). Climate Change and the Global Energy Challenge. Oxford University Press.
19	Sachs, J. D. (2015). *The age of sustainable development*. Columbia University Press.
20	Singh, J. S., & Gupta, S. R. (2021). Ecology, Environment and Resource Conservation. S. Chand Publications.
21	Singh, R. B., & Mal, S. (2014). Environmental Change and Sustainability. Springer.
22	Somanathan, E. (2020). The economics of India’s climate policy. *Indian Economic Review*, *55*(2), 267–292.
23	Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge University Press.
24	UNDP. (2021). *Human Development Report 2021–22: Uncertain times, unsettled lives*. United Nations Development Programme.
25	UNFCCC. (2015). *The Paris Agreement*. United Nations Framework Convention on Climate Change.
26	World Bank. (2022). *State and trends of carbon pricing 2022*. Washington, D.C.:

	World Bank Publications.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Debate and/or internship	10

Employability for the Course / Programme

This course enables the student to get a strong interdisciplinary foundation on climate change and disaster management, preparing them for careers and research opportunities in the rapidly evolving fields of environment and biological science.

38	Environmental Impact Assessment and Conservation Management		KU8DSEPLS413
DSE	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Conduct screening, scoping, and baseline environmental assessments.
CO2	Apply analytical tools and models for predicting and mitigating environmental impacts.
CO3	Critically evaluate EIA reports and recommend appropriate mitigation measures.
CO4	Incorporate biodiversity and conservation principles into environmental management plans.
CO5	Use GIS and remote sensing in environmental monitoring and reporting.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course is suitable for postgraduate or advanced undergraduate environmental science or

sustainability studies.
• *First module introduces the ecological and policy background essential for understanding Environmental Impact Assessment.* • *Second module delves into the procedural and methodological backbone of EIA.* • *Third module focuses on applied aspects of EIA across diverse sectors—industry, infrastructure, mining, and power generation.* • *Finally, last module connects impact assessment outcomes to practical conservation and management strategies.*
This course will emphasize role of EIA as a bridge between science, society, and sustainable governance..

Course Objectives:

1. To understand the scientific and policy basis of Environmental Impact Assessment.
2. To develop the ability to apply EIA methodologies in varied development contexts.
3. To interpret and evaluate environmental data for decision-making.
4. To integrate biodiversity conservation and sustainable management principles into project planning.
5. To familiarize students with GIS tools, environmental legislation, and global EIA practices.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (6+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Environment, Sustainability, and the Foundation of EIA (12 hrs) 1.1. Environment and Its Components: Definition, structure, and composition of the environment — air, water, land, and biota.Ecological hierarchy: species, community, ecosystem, landscape levels.Environmental quality indices and ecological carrying capacity.Anthropogenic pressures and environmental degradation trends in India. 1.2. Introduction to Environmental Impact Assessment (EIA): Concept, purpose, and scope of EIA in environmental planning.Historical evolution: NEPA (1970, USA), global adoption, and Indian legal framework.Screening, scoping, and baseline environmental data collection.Linkages with environmental auditing and strategic environmental assessment (SEA). 1.3. Sustainable Development and Environmental Policy Integration: Principles and goals of sustainable development.Interrelationship between economy, ecology, and society. Brundtland Report, Agenda 21, SDGs, and national sustainability indicators. Balancing developmental needs with environmental protection — trade-offs and ethics. 1.4. Environmental Quality and Monitoring Systems. Environmental quality indicators: air, water, soil, and biological parameters.Monitoring techniques — in situ sampling, remote sensors, biological indicators. Baseline environmental surveys and environmental data management.
Module 2: EIA Process, Methods, and Public Participation (12 hrs) 2.1. EIA Process and Steps: Impact identification, prediction, evaluation, and mitigation.EIA report preparation and Environmental Management Plan (EMP).Environmental clearance process under MoEFCC and State Pollution Control Boards. Post-project monitoring and compliance auditing.

2.2.EIA Methodologies: Comparative review: ad-hoc, checklist, matrix (Leopold's Matrix), overlay, and network methods. Quantitative approaches: cost-benefit analysis, risk assessment, multicriteria evaluation. Use of modeling in prediction (air dispersion, hydrological and ecological models). Selection criteria for EIA methodology based on project type. 2.3.Impact Assessment of Environmental Media: Assessment of impacts on air, water, soil, and biota. Techniques for predicting pollutant dispersion and contamination. Assessing cumulative and synergistic impacts. Environmental risk and health impact assessment. 2.4.Public Involvement and Decision Making. Role of stakeholders in the EIA process — local communities, NGOs, policymakers. Public hearing procedures under EIA Notification (2006). Access to information, transparency, and the Aarhus Convention principles. Conflict resolution, ethics, and participatory environmental governance.
Module 3: Sectoral Applications, Tools, and Case Studies (12 hrs) 3.1. Environmental Impacts of Development Projects: Dams, hydroelectric projects, power plants, transportation networks, and urban expansion. Mining and quarrying — land degradation and water pollution case studies. Industrial projects and waste management facilities — EIA protocols. Disaster impact assessment and climate resilience considerations. 3.2. Air, Water, and Soil Pollution — Impacts and Controls: Sources, impacts, and mitigation strategies.National Ambient Air and Water Quality Standards (NAAQS, CPCB). Solid and hazardous waste management in EIA context. Integration of pollution control plans with environmental management systems (EMS). 3.3. GIS and Remote Sensing Applications in EIA: Use of geospatial tools for mapping and impact visualization. Satellite data integration for land-use and vegetation change analysis. GIS-based buffer analysis, overlay modeling, and hazard zoning. Software and databases: ArcGIS, QGIS, Bhuvan, Google Earth Engine. 3.4. Case Studies and Best Practices: Case study analysis: Mining in Goa, Silent Valley Hydroelectric Project, Vizhinjam Port Project. Lessons learned from successful and failed EIA implementations. Role of EIAs in national environmental policy and planning. Comparative study of EIA systems: India, USA, and the EU.
Module 4. Environmental Management, Biodiversity, and Conservation (12 hrs) 4.1.Environmental Management Plans (EMPs): EMP formulation, implementation, and monitoring. Mitigation hierarchy: avoidance, minimization, restoration, and compensation. Environmental auditing, ISO 14001 certification, and Environmental Management Systems (EMS). Linking EIA outcomes with Sustainable Development Goals (SDGs). 4.2.Biodiversity and Conservation Principles: Concepts and patterns of biodiversity: microbial, plant, soil, and agro-biodiversity. Levels of biodiversity: alpha, beta, gamma diversity. Biodiversity gradients: latitudinal and insular variations. Economic and ecological value of biodiversity in development planning. 4.3.Threats to Biodiversity and Policy Frameworks: Habitat loss, fragmentation, invasive species, pollution, and overexploitation. IUCN Red List categories: endangered, threatened, and vulnerable species. National Biodiversity Authority (NBA), Red Data Book, and documentation systems.Legal and ethical aspects of biodiversity protection — Biological Diversity Act (2002). 4.4.Conservation Methods and Strategies: *In situ* conservation: Biosphere reserves, national parks, sanctuaries, sacred groves. *Ex situ* conservation: botanical gardens, gene banks, seed and tissue culture banks, DNA repositories. Role of indigenous knowledge and community participation. Global conventions: CBD, CITES, Ramsar, and UNESCO MAB program.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for

this module is ***strictly internal***.
Theory 12 Hrs
EIA and Society: Community Perceptions and Social Outcomes: Influence of EIA on community awareness and participatory decision-making. Role of EIA in conflict resolution between local populations and developers.
EIA and Local Self-Government (LSGA) Involvement: Role of Panchayats, Municipalities, and District Planning Committees in EIA implementation. Decentralized environmental governance under the Kerala Panchayati Raj Act and Biodiversity Management Committees (BMCs). Community-level environmental monitoring, People's Biodiversity Registers (PBRs), and Grama Sabha consultation.
EIA in Industrial and Corporate Decision-Making: Role of EIA in project design, site selection, and compliance for industries (manufacturing, mining, power, ports, tourism). Integration of EIA with Corporate Environmental Responsibility (CER) and Environmental, Social, and Governance (ESG) frameworks. Economic and operational benefits of proactive EIA adoption — risk mitigation, reduced liability, and brand credibility.
Practical 10 Hrs
1. Field visit to newly 'developing area'.
2. Collection of reports on EIA studies in different ventures.

Suggested Assignment Topics- Theory
1. Examples for modified planning due to EIA recommendations
2. Destiny of EIA studies related forests and its boundaries and Mangrove boundaries

Suggested Assignment Topics- Practical
1. Study the biodiversity in a newly developing area as a part of EIA.
2. Participation in LSGA and BMC activities of your locality regarding EIA

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Arts, J., & Morrison-Saunders, A. (2004). Environmental impact assessment follow-up and adaptive management. *Environmental Impact Assessment Review, 24*(4), 463–479.
2	Canter, L. W. (1996). *Environmental impact assessment* (2nd ed.). McGraw-Hill.
3	Canter, L. W., & Sadler, B. (1997). *A tool for better environmental decision-making: A practitioner's guide to EIA.* International Association for Impact Assessment.
4	Cashmore, M. (2004). The role of science in environmental impact assessment: Process and procedure versus purpose in the development of theory. *Environmental Impact Assessment Review, 24*(4), 403–426.
5	Central Pollution Control Board (CPCB). (2018). *Guidelines for environmental monitoring and assessment.* CPCB, New Delhi.
6	Clark, B. D., Chapman, K., Bisset, R., & Wathern, P. (1978). *Environmental impact assessment: A review.* Allen & Unwin.
7	European Commission. (2017). *EIA Directive 2014/52/EU: Guidance on the application of the Environmental Impact Assessment Directive.* European Union.
8	Glasson, J., & Salvador, N. N. B. (2000). EIA in Brazil: A procedures–practice gap. *Environmental Impact Assessment Review, 20*(2), 191–225.
9	Glasson, J., Therivel, R., & Chadwick, A. (2012). *Introduction to environmental impact assessment* (4th ed.). Routledge.
10	International Association for Impact Assessment (IAIA). (2022). *Principles of environmental impact assessment best practice.* IAIA Publications.
11	Jay, S., Jones, C., Slinn, P., & Wood, C. (2007). Environmental impact assessment: Retrospect and prospect. *Environmental Impact Assessment Review, 27*(4), 287–300.

	https://doi.org/10.1016/j.eiar.2006.12.001
12	Lawrence, D. P. (2003). *Environmental impact assessment: Practical solutions to recurrent problems.* Wiley.
13	Ministry of Environment, Forest and Climate Change (MoEFCC). (2006). *EIA Notification, 2006.* Government of India.
14	MoEFCC. (2020). *Draft EIA Notification, 2020.* Government of India.
15	Morgan, R. K. (2012). Environmental impact assessment: The state of the art. *Impact Assessment and Project Appraisal, 30*(1), 5–14. https://doi.org/10.1080/14615517.2012.661557
16	Morris, P., & Therivel, R. (2009). *Methods of environmental impact assessment* (3rd ed.). Routledge.
17	Morrison-Saunders, A., Baker, J., & Arts, J. (2003). Lessons from practice: Towards successful follow-up. *Impact Assessment and Project Appraisal, 21*(1), 43–56.
18	National Environmental Engineering Research Institute (NEERI). (2016). *Environmental impact assessment manual for industrial projects.* NEERI, India.
19	Noble, B. F. (2015). *Introduction to environmental impact assessment: A guide to principles and practice* (3rd ed.). Oxford University Press.
21	Organisation for Economic Co-operation and Development (OECD). (2019). *Good practice principles for environmental assessment.* OECD Environment Directorate.
22	Petts, J. (Ed.). (1999). *Handbook of environmental impact assessment* (Vols. 1–2). Blackwell Science.
23	Pope, J., Annandale, D., & Morrison-Saunders, A. (2004). Conceptualising sustainability assessment. *Environmental Impact Assessment Review, 24*(6), 595–616.
24	Sánchez, L. E., & Gallardo, A. L. C. F. (2005). On the successful implementation of strategic environmental assessment in Brazil. *Impact Assessment and Project Appraisal, 23*(2), 137–146.
25	Toro, J., Requena, I., Duarte, O., & Zamorano, M. (2010). A qualitative method proposal to improve environmental impact assessment. *Environmental Impact Assessment Review, 30*(5), 334–342.
26	United Nations Development Programme (UNDP). (2019). *Integrating environment into development planning: EIA case studies.* UNDP Environment and Energy Group.
27	United Nations Environment Programme (UNEP). (2018). *Environmental impact assessment and strategic environmental assessment: Towards an integrated approach.* UNEP Division of Technology, Industry and Economics.
28	Wathern, P. (Ed.). (1988). *Environmental impact assessment: Theory and practice.* Routledge.
29	Weston, J. (2004). *EIA: A critical review.* Longman.
30	Wood, C. (2003). *Environmental impact assessment: A comparative review* (2nd ed.). Prentice Hall.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70

Continuous Comprehensive Assessment CCA	30
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal Practical Examination	10

Employability for the Course / Programme

This course equips students for careers in environmental consultancy, policy analysis, sustainability auditing, GIS-based environmental planning, and biodiversity management within governmental, industrial, and NGO sectors.

39	Structural biology		KU8DSEPLS414
DSE	Semester: 8	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the hierarchy and organization of biomolecular structures.
CO2	Describe key experimental techniques used to determine macromolecular structures.
CO3	Apply computational tools for structure modeling and functional interpretation.
CO4	Analyze structural information in the context of biological mechanisms and drug design.
CO5	Perform basic bioinformatics and sequence-based analyses to support structural investigations.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course provides an in-depth understanding of the principles, methods, and applications of structural biology.
• *First module builds a strong conceptual foundation of biomolecular structures and their biological significance.*

• *Second module dives into experimental methods used to determine biomolecular structures.* • *Third module explores computational approaches to analyze, model, and predict structures.* • *Last module helps to apply structural knowledge to understand biological mechanisms and drug design.*
Students will explore the architecture and dynamics of biomolecules through experimental and computational methods, with emphasis on how structural knowledge informs function and drug discovery.

Course Objectives:

1. To understand the hierarchical organization and physical principles underlying biomolecular structure.
2. To gain practical knowledge of experimental and computational methods.
3. To develop proficiency in structural data handling and visualization.
4. To explore the role of structure in biological regulation, protein engineering, and drug design.
5. To foster an integrative understanding of modern structural biology.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
4	0	4	4+ 0+ 0 (6+ 0 + 0)	4	30	70	100

COURSE CONTENT

Module 1: Fundamentals of Structural Biology (12 hours) 1.1.Levels of Biomolecular Structure: Primary, secondary, tertiary, and quaternary structures. Structure–function relationships in proteins and nucleic acids 1.2.Molecular Interactions and Forces: Hydrogen bonding, hydrophobic interactions, van der Waals forces, ionic bonds. Protein folding and stability. 1.3.Structural Databases and Visualization: Protein Data Bank (PDB), SCOP, CATH, UniProt. Tools: PyMOL, Chimera, RCSB PDB viewer 1.4.Introduction to Structural Determination Techniques: X-ray crystallography, NMR spectroscopy, cryo-electron microscopy. Overview of hybrid and integrative structural biology
Module 2: Module 2: Experimental Techniques in Structural Biology (12 hours) 2.1.X-ray Crystallography: Crystallization, diffraction, data collection, structure refinement. 2.2.NMR Spectroscopy: Principles, isotope labeling, structure calculation from NMR data 2.3.Cryo-Electron Microscopy (Cryo-EM): Sample preparation, image processing, single-particle analysis 2.4.Small-Angle Scattering & Mass Spectrometry: SAXS and WAXS basics. Structural mass spectrometry and cross-linking methods
Module 3: Module 3: Computational Structural Biology (12 hours) 3.1.Homology Modeling and Fold Recognition: Template selection, model building, validation 3.2.Molecular Docking: Ligand–protein interactions, docking algorithms, AutoDock, HADDOCK 3.3.Molecular Dynamics Simulations: Force fields, simulation setup, trajectory analysis 3.4.Structure Prediction and AI Methods: AlphaFold and RoseTTAFold. Machine learning in structural prediction.
Module 4: Structural Biology Applications and Frontiers 12 hours 4.1.Protein Engineering and Design: Rational and directed evolution approaches

4.2.Structural Genomics and Proteomics: Large-scale structure determination efforts 4.3.Drug Discovery and Design: Structure-based drug design (SBDD) and virtual screening 4.3.Emerging Trends and Integrative Approaches: Cryo-tomography, hybrid modeling, and multi-omics integration.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 2Hrs** From Structure to Society: The Impact and Future of Structural Biology: Integration of structural biology with *systems biology*, *synthetic biology*, and *AI-driven life sciences*. **Innovation and Entrepreneurship:** Structural biology in biotech startups and pharmaceutical R&D pipelines. Opportunities for patenting protein design, biosensors, and therapeutic targets. **Future Directions:** Quantum biology and cryo-EM revolution. Integrative modeling and personalized medicine. AI-enhanced protein design (AlphaFold, RoseTTAFold) as disruptors of traditional biology. **Practical 10 Hrs** 1. Exploring the PDB Database – retrieving and visualizing protein structures. 2. Protein Structure Visualization using PyMOL – highlighting secondary structures 3. Analyzing Intermolecular Interactions – identifying hydrogen bonds and salt bridges 4. Homology Modeling using SWISS-MODEL or MODELLER 5. Protein–Ligand Docking using AutoDock Vina 6. Molecular Dynamics Setup using GROMACS – energy minimization and equilibration 7. Cryo-EM Map Fitting with Chimera 8. NMR Structural Data Interpretation using NMRView or CCPNMR 9. Validation of Structural Models using MolProbity 10. Structure-based Drug Design Workflow – virtual screening and hit identification

Suggested Assignment Topics- Theory

1. Structural bioinformatics and its uses
2. Major structure visualisation tools
3. Autodocking tools

Suggested Assignment Topics- Practical

1. Structure prediction using the different sequences of the same gene in different species
2. Drug designing

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Branden, C., & Tooze, J. (1999). *Introduction to protein structure* (2nd ed.). Garland Science.
2	Mount, D. W. (2004). *Bioinformatics: Sequence and genome analysis* (2nd ed.). Cold Spring Harbor Laboratory Press.
3	National Center for Biotechnology Information (NCBI). (2024). *Basic Local Alignment Search Tool (BLAST)*. https://blast.ncbi.nlm.nih.gov/Blast.cgi
4	Petsko, G. A., & Ringe, D. (2004). *Protein structure and function*. Oxford University Press.
5	Pettersen, E. F., Goddard, T. D., Huang, C. C., & Ferrin, T. E. (2024). *UCSF Chimera: Visualization system for exploratory research and analysis*. University of California, San Francisco. https://www.cgl.ucsf.edu/chimera/
6	Research Collaboratory for Structural Bioinformatics Protein Data Bank (RCSB PDB). (2024). *RCSB Protein Data Bank*. https://www.rcsb.org

7	Schrödinger, LLC. (2024). *PyMOL: Molecular graphics system* (Version 2.5). https://pymol.org
8	Waterhouse, A., Bertoni, M., Bienert, S., Studer, G., Tauriello, G., Gumienny, R., Heer, F. T., de Beer, T. A. P., Rempfer, C., Bordoli, L., Lepore, R., & Schwede, T. (2018). *SWISS-MODEL: Homology modelling of protein structures and complexes*. Swiss Institute of Bioinformatics. https://swissmodel.expasy.org
9	Aloy, P., & Russell, R. B. (2006). Structural systems biology: Modelling protein interactions. Nature Reviews Molecular Cell Biology, 7(3), 188–197. https://doi.org/10.1038/nrm1858
10	Baxevanis, A. D., & Ouellette, B. F. F. (Eds.). (2005). Bioinformatics: A practical guide to the analysis of genes and proteins (3rd ed.). Wiley-Blackwell
11	Lesk, A. M. (2019). Introduction to bioinformatics (5th ed.). Oxford University Press.
12	Mount, D. W. (2004). Bioinformatics: Sequence and genome analysis (2nd ed.). Cold Spring Harbor Laboratory Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal Practical Examination	10

Employability for the Course / Programme

This course integrates concepts from molecular biology, biochemistry, biophysics, and computational biology, fostering a multidisciplinary skill set essential for modern bioscience careers.

40	Project		KU8PRJPLS415
PRJ	**Semester: 8**	**Hrs/week: 32 or 48**	**Credits: 8 or 12**

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Ability to formulate research questions, develop hypotheses, and design scientifically valid experiments or field studies using appropriate methodologies.
CO2	Gaining proficiency in collecting, analyzing, interpreting, and presenting quantitative and qualitative data using modern tools, statistical techniques, and digital platforms.
CO3	Ability to integrate concepts from various scientific disciplines to address complex, real-world problems through innovative and evidence-based approaches.
CO4	Effective communication of scientific findings through written reports, presentations, posters, or publications following standard academic and ethical norms.
CO5	Exhibition of scientific integrity, teamwork, and awareness of ethical, environmental, and societal implications of scientific research, contributing responsibly to sustainable development and community well-being.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
The **Project Course** serves as the capstone component of the undergraduate science programme, designed to immerse students in the authentic process of *doing science*. It provides a hands-on

platform for students to apply theoretical knowledge, explore research questions, and develop problem-solving abilities through independent or guided investigation.
By engaging in experimental, field-based, or computational projects, students experience the complete research cycle—from conceptualization and data collection to analysis, interpretation, and dissemination.
This course nurtures *scientific temperament, creativity, critical thinking, and ethical responsibility*, preparing learners for advanced studies, research careers, and evidence-based decision-making in scientific and societal contexts. It embodies the spirit of inquiry and innovation

Course Objectives:

1. To cultivate scientific curiosity and inquiry skills by engaging students in identifying, defining, and investigating real-world scientific problems through systematic research approaches.
2. To develop competence in experimental design and research methodology, enabling students to plan, execute, and refine laboratory, field, or computational investigations independently or collaboratively.
3. To strengthen analytical and critical thinking abilities by training students to collect, organize, and interpret scientific data using appropriate statistical and computational tools.
4. To enhance scientific communication and documentation skills through the preparation of research proposals, reports, presentations, and publications that adhere to professional and ethical standards.
5. To foster interdisciplinary thinking and societal relevance, encouraging students to apply scientific knowledge to sustainable development, innovation, and community-based problem solving

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
0	8/12	8/12	0+ 32+ 0 or 0+ 48 + 0	32/48	60 or 90	140 or 210	200 or 300

Mandatory/Optional Project

In the eighth semester, a mandatory 12-credit project (minimum 360 working hours) is required for FYUGP research or honors, or an optional 8-credit project (minimum 240 working hours) alongside a major theory course. Project guidance can be provided by a faculty member of the department. If necessary, the expertise of an external guide may be utilized. Facilities and expertise for the project can be on-campus or off-campus, with required permissions for off-campus projects. Students must maintain and submit a project log book/register along with the final report.

Student Responsibilities: Suggesting the topic, discussing with the project guide and peers, reviewing literature, planning and designing the project, experimentation, data analysis, and preparing and presenting the project report.

Teacher/Supervising Guide Responsibilities: Confirming the topic, demonstrating, planning experimentation, providing guidance, and correcting and certifying the project.

Evaluation of Project

A student pursuing UG Honours with research must complete a mandatory research project worth 12 credits by the end of the eighth semester. For other UG Honours students, the project is optional. Since each credit corresponds to 25 marks, the 12-credit project will be evaluated for a total of 300 marks. The evaluation scheme for the project is detailed below:

Project type	Maximum Marks	CCA (30%)	ESE (70%)
Research Project of 12 Credits	300	90 Pre synopsis presentation and viva Review of literature Regularity and Participation (1:1:1)	210 Report, Methodology, Social Relevance, Scientific accuracy, innovation, data analysis, presentation skill ,viva (components and their relative weightage can be decided by the department council)
Research Project of 8 Credits	200	60 Pre synopsis presentation and viva Review of literature Regularity and Participation (1:1:1)	140 Report, Methodology, Social Relevance, Scientific accuracy, innovation, data analysis, presentation skill, viva (components and their relative weightage can be decided by the department council)

Employability for the Course / Programme

This is one of the fascinating course of the whole programme that will help the student to nurture the seeds of doing science.

41	Diversity of Plants I	KU1DSCBOT103
Semester : 1 **Hrs/week: 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Acquisition of basic knowledge in the cell structure and diversity among life forms, especially on lower plants and fungi.
CO2	Understanding of the terms used cell biology and also in the description of diverse forms of life.
CO3	Understanding the basic differences that exist among different groups of plants.
CO4	Ability to apply the concepts gathered in this course to the field of evolution and advanced diversity and ecological studies.
CO5	Firsthand experience in viewing the diversity using laboratory procedures and there by induction of enthusiasm in biological studies.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√		√	√						
CO3						√						
CO4									√	√		
CO5											√	√

Course Description
This is an introductory biology course designed for UG students in general and BSc Zoology BSc Microbiology and BSc Forestry in particular. The aim of the course is to give basic knowledge about the diversity of plant life forms.

• *First module gives details on plant cell structure* • *Second module focuses on the diversity of cell structure* • *Third module gives a detailed account on vegetative and reproductive structures of fungi, which enables the student to understand the classification of fungi.* • *Fourth module is a brief account on the diversity of algae, bryophytes and Pteridophytes and their economic importance and their classification.*
This course will also provide you opportunities to observe diverse forms of plant life of lower groups including fungi, during laboratory sessions.

Course Objectives:

1. Understanding of the fundamental structure of cells.
2. Concept development in structure and reproduction of lower plants- algae and bryophytes and fungi.
3. Enable the student to appreciate bio diversityfor sustainable development.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/entrepreneurship.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Cells and Structure of plants (10 hrs)

1.1. History - History of the progress of cell biology and development of cell theory. Origin and Evolution of cell. Characteristics of prokaryotic and eukaryotic cells.

1.2. Brief history of classification of organism from Aristotle's days to modern days. Six Kingdom Classification.

1.3. Levels of organization of cells up to organism. Macroscopic forms of plant life: Brief morphological and functional account on Root, Stem, Leaf, Flower, Fruit and Seed.

1.4. Morphological Comparison of Herbs, Shrubs, Trees, Creepers, Twiners, Lianas and Epiphytes.

Module 2. Diversity of cell structure (15 hrs)

1. Cell as a unit of structure and function. Modern concept on cell. A brief account on plant cell structure.
2. Cellular envelopes- Types and functions - Cell wall - Chemistry, Ultra structure and function of Plant cell wall. Thickening of cell wall, Pits and pit apertures. Plasmodesmata.
3 Protoplasm and Cytoplasm. A brief account of cell organelles and Non living inclusions plant cell. Chloroplast – structure and function.
4. Comparative account of cell structure and cell organelles among different lower plant groups- Algae, Bryophytes and Pteridohytes.

Module 3. Fungi (8 hrs)

3.1. General characters of Fungi and classification by Ainsworth (brief account).

3.2 General account on thallus structure and fruiting bodies among different fungal groups- Ascocarps, basidiocarps, ascogonium, perithecium, ascothecium, cleistothecium,

3.3. General account of Lichens- classification based on thallus morphology; major mycobionts and phycobionts.

3.4 Economic and ecological importance of fungi and lichens. Major Fungal diseases of plants, pets and human beings.

Module 4. Diversity of plants (12 hrs)

4.1. General characters of algae and their classification up to classes (F E Fritsch); Range of thallus variation in Algae.

4.2. Salient features of Bryophytes and brief account on their classification

4.3. General account on the characteristics of Pteridophytes and brief account on their classification

4. 4 Economic and ecological importance of Algae and Bryophytes and pteridophytes: food, industry, medicine, biofertilizers; algal bloom. Importance of Algae in Fisheries and livestock management. Role of Algae and Bryophytes in ecological succession and soil formation.

Module 5. TEACH Space (15 hrs):

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Compound microscope and its parts.

2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Crinum*/*Rheo*.
3. Diversity of cells- prokaryotic (*Nostoc*), eukaryotic (*Spirogyra*, *Oedogonium*, stomata of different leaves, Trichomes).
4. Study of non-living inclusions: cystolith (*Ficus*), raphides (*Pistia*), aleurone grains(Castor) and Starch grains (Rice, Wheat and Potato)
5. Photographs of Herbs, Shrubs, Trees, Creepers, Twiners, Lianas and Epiphytes from local sites.
6. Geotaggged Photographs of algae (2), bryophytes (5) and Pteridophytes(10).
7. Geotagged photographs of any 5 fungal fruiting bodies from the premises of.house and college
8. Collection, classification and documentation of different types of plants- algae, bryophytes and Pteridophytes.
9. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Geological time scale
2. Theories and experiments on evolution of life- classical and modern
3. Comparative account on different plant groups
4. Comparative account on prokaryotes and eukaryotes

Suggested Assignment Topics- Practical

1. Microphotographs of different stomata and trichomes
2. Collection of different mushrooms and their submission
3. Preparation of Album of fungal fruiting bodies.

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	De Robertis E.D. and De Robertis E.M.F. (2017). Cell and Molecular Biology 8th Edition. Lee and Fab International edition, Philadelphia.	1, 2
2	Pawar, (2019).Cell Biology, Himalaya Publishing House, Mumbai.	1, 2
3	Rastogi, S.C. (2016).Cell and Molecular Biology. New Age International Publishers, New Delhi.	1, 2
4	Verma P.S. and Agarwal V.K. (2016).Cell Biology (Cytology, Biomolecules, Molecular biology),Paper back, S.chand and Company .Ltd.	1, 2,
5	Kumar H D and H N Sharma, (1979). A textbook on Algae,	4
6	Dube, H.C. (2008). Fungi, Bacteria and Viruses. Agrobios	3
7	Sambamurty A. V. S. S., (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International publication, New Delhi.	4
8	Arumugam N, Annie Ragland and V Kumaresan, A textbook of Botany, Saras Publication	4
9	Annie Ragland, V Kumaresan and Arumugam N, (2020). A text of Botany- algae, Fungi, Bryophytes, Microbiology and Plant Pathology, Saras Publication.	3, 4
10	Pandey, S. N. & Misra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.	4
Core Compulsory Readings		
1	Karp, G. (2010), Cell Biology, John Wiley & Sons, U.S.A. 6th edition.	
2	Misra, A., & Agrawal, P. R., (1978). Lichens. Oxford and IBH, NewDelhi	
3	Singh, G. (2010). Plant systematics - an integrated approach (3rd Edn) Science Publishers	

4	Bell, A.D (1991). Plant form- An illustrated guide to Flowering plant morphology. Oxford University Press, New York, Tokyo.	
5	Gangulee, S.C., Das, K.S., Dutta, C.D., & Kar, A.K., (1968). College Botany Vol. I, II and III. Central Education Enterprises.	
Core Suggested Readings		
1	Starr, C., (2007). Biology: concepts and applications. VI edn. Thomson Press.	
2	Raven, P.H., Evert, R.F., & Eichhorn, S.E., (2013). Biology of plants. VIIIth Ed. W.H. Freeman Publishers.	

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question
- ➢ What are the two main types of cells, and what distinguishes them from each other?
- ➢ List out any four features of fluid mosaic model of the cell membrane and its significance in cell biology.
- ➢ Differentiate pit from pit fields
- ➢ What are the functions of plant roots?
- ➢ Differentiate phycobiont from mycobiont with examples

3 Marks Questions (Applying and Analyzing):
- ➢ Using a diagram, illustrate the structure of a plant cell wall and explain its functions.
- ➢ The distribution and structure of chloroplast helps in the functioning of photosysntheis. Substantiate.
- ➢ Analyze the implications of the endosymbiotic theory for our understanding of cellular evolution.
- ➢ Explain the vegetative thallus of ascomycete fungi.

5 Marks Questions (Evaluating and Creating):
- ➢ Evaluate the impact of advancements in cell biology on modern scientific research and technology.
- ➢ Knowledge in biodiversity is highly essential for the economic growth and human welfare. Substantiate the statement.

Employability for the Course / Programme

It is one of the basic courses which is very helpful in understanding the fundamental concepts in cell biology as well as in diversity of life

42	Plant Ecology and Phytogeography	KU1DSCBOT104
Semester : 1 **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Acquisition of basic knowledge in ecology and phytogeography.
CO2	Understanding the dynamic nature of ecosystems in particular and biosphere in general.
CO3	Understanding the basic relationships that exist among different species.
CO4	Ability to apply the concepts gathered in this course to the field of evolution and modern ecology
CO5	First -hand experience in observing the major ethical and legal aspects in environmental sciences.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√							
CO3			√	√								
CO4								√	√	√		
CO5											√	√

Course Description
This is an intermediate minor course designed for BSc Zoology, Forestry and Microbiolgy students. It emphasizes on the basic principles and processes that are very relevant to the vast field of environmental sciences.
• *First module is an introduction to environmental sciences.* • *Second module emphasizes on the basic structure of Ecosystem* • *Third module is related to the function and dynamics of ecosystem.* • *Fourth module is mainly focused on the basic principles of phytogeography and relationship of plant with biodiversity.*
This course will also provide opportunities to do some laboratory work to find out the adaptations of plants as well as regional differences in physicochemical parameters of various ecosystems.

Course Objectives:

1. To enable the student to appreciate bio diversity and the importance of various conservation strategies, laws and regulatory authorities.
2. To recognise the need for more research to create a baseline data for sustainable exploitation- Think globally and Act locally
3. To observe and analyse the interrelationship between the geography and pattern of distribution of plants.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Introduction to Environmental Science (5 hrs)

1.1. History, scope and importance of ecology and environmental science.
1.2. Difference between ecology, environmental biology and environmental science and environmental studies.
1.3. Branches of ecology- autecology, synecology.
1.4. Motto and Achievements of Major Indian Institutes and Research Centres in Ecology and Environmental Science.

Module 2. Basic Structure of Ecosystem (8 hrs)

1. Structure and hierarchy of ecological units- species, population, community, ecosystem, biome and biosphere.
2. Basic structure of ecosystem- Factors affecting the structure of ecosystem-biotic- Producers, consumers and decomposers; and abiotic- climatic, edaphic, physiographic.
3. Concept of food chain and food web, Energy flow, 10% theory. Ecological Pyramids- Pyramid of numbers, biomass and energy. Erect and inverted.
4. General structure of pond and forest ecosystem.

Module 3. Function and Dynamics of Ecosystem (20 hrs)

3.1. Concept of Productivity. Primary productivity, Secondary Productivity, GPP and NPP. Comparative account on productivity major ecosystems in the biospehere. Concept of Biogeochemical Cycles. Carbon Cycle, Nitrogen Cycle, Sulphur and Phosphorus Cycle. Water Cycle.
3.2. Concept of habitat and ecological niche, Ecotone and Edge Effect. Concepts in ecospecies- Ecads and Ecotypes.
3.3. Concept of Succession: Types, characteristic features, structure of each substages in Xeracrh, Hydrarch and Mesarch.
3.4. Adaptations -morphological, anatomical and physiological in Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

Module 4. Role of plants and Phytogeography (12 hrs)

4.1. Role of plants in structure, function and evolution of existing ecosystems. Deforestation and its ill effects on biodiversity and ecosystems.
4.2. Biodiversity. Definition and Types. India as a megadiversity centre. Endangered and endemic plants of India with special emphasis to Western Ghats.
4.3. Phytogeography- Definition, concepts --Descriptive and dynamic -Continental drift, age and area theory,
4.4. Plant migration and barriers. Topographic factors- Altitude and latitude. Vegetation types of India

.Module 5. TEACH Space (15 hrs):

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Study of ecological and anatomical modifications of xerophyte, hydrophyte, halophyte, parasite and epiphyte.
2. Estimation of DO and BOD and calculate the primary productivity of pond water.
3. Observation of ecads and ecotypes, if available in the college campus.
4. Estimation of biodiversity in the premises of house and college campus.
5. Collection of maps showing hotspots of biodiversity.
6. Visit to a local polluted site and/or reserve forest. for documentation of major pollutants/species
7. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Structure of Ecosystem
2. Food chain and Food Webs in Nearby locality
3. Vegetation types of India

Suggested Assignment Topics- Practical

1. Visit to pond ecosystem and estimation of physicochemical parameters
2. Estimation DO in different temperatures

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Kumaresan V and N Arumugam, 2020. *Plant Ecology & Phytogeography* – Saras Publication	1, 2, 3,4
2	Deka U and T Datta, 2023. *Plant Ecology and Phytogeography*, Asian Humanities Press	1, 2, 3, 4
3	Ambasht RS and N K Ambasht, 1988. Text book of Plant Ecology, Students Friends.	1,2, 3
4	Bhatnagar A, 2010. Ecology and Environment. Oxford	1, 2,3
5	Bharucha F R, 1983. A text book of the Plant Geography of India, Oxford University Press.	4
6	Mc Dougall, W B B, 2022. Plant Ecology, Legare Street Press.	2, 3
Core Compulsory Readings		
1	Kormondy, E. 1989. *Concepts of Ecology* (3rd Ed.). Printice Hall of India, New Delhi.	
2	Schulze E. D., Beck, E., & Klaus Mü̈ller-Hohenstein. (2005). Plant ecology. Springer.	
Core Suggested Readings		
1	Bock, J. H., Linhart Y B, Stebbins G L and C E Turner, 2020. The Evolutionary Ecology of plants. CRC Press.	
2	Pullaiah, T, 2024. Biodiversity Hotspot of the Western Ghats and Sri Lanka. Apple Academic Press.	

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments	➢ Lecturing
➢ Collaborative learning-Group	➢ ICT
discussion	➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question

- based on Edge effect.
- List out any two environmental science research institutes in India and their major achievements
- Define ecological niche with example.
- Differentiate GPP and NPP
- List out the similarities of Food Chain and Food web
- Enlist any four morphological adaptations of Xerophytes with example. 3 Marks Questions (Applying and Analyzing):
- Discuss the adaptive features of Halophytes and list out the similarities with xerophytes.
- How does altitude and latitude influences the plant vegetation?
- What are the similarities and dissimilarities between autecology and synecology. 5 Marks Questions (Evaluating and Creating):
- How do anthropogenic land conversion and natural succession influence ecosystem dynamics? Illustrate with specific impacts on biodiversity and ecosystem services.

Mangrove ecosystems are found to be more productive and diverse. Substantiate and evaluate this statement

Employability for the Course / Programme

It is one of the basic minor courses which is very essential for understanding the diversity of plants and their ecosystems.

43	Reproduction and Life cycle of plants	KU2DSCBOT105
Semester : 2 **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Acquisition of basic knowledge in diversity of reproduction and life cycle among life forms, especially plants.
CO2	Understanding of the terms used in the description of diverse forms of life.
CO3	Understanding the basic differences that exist among different reproductive methods of plants.
CO4	Ability to apply the concepts gathered in this course to the field of evolution and advanced diversity and ecological studies.
CO5	Firsthand experience in viewing the diversity using laboratory procedures and there by induction of enthusiasm in biological studies.

<u>Mapping of Course Outcomes to PSOs/POs</u>

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√							
CO3			√				√					
CO4								√	√			
CO5											√	√

Course Description
This is an introductory biology course designed for UG students in general and BSc Zoology BSc Microbiology and BSc Forestry in particular. The aim of the course is to give basic knowledge about the diversity of plant life forms.
• *First module deals with the reproduction and life cycles of plants.* • *Second module focuses on the reproduction algae and bryophytes.* • *Third module gives an idea on the reproduction of pteridophytes and gymnosperms.* • *Fourth module delves into the reproduction in angiosperms.*
This course will also provide opportunities to observe and experience diverse forms of plant reproduction through various laboratory sessions.

Course Objectives:

1. Understanding of the fundamental concepts in reproduction and life cycle of plants.
2. Concept development in diversity of general growth and development plants.
3. Enable the student to appreciate bio diversity.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/enterpreneurship

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Reproduction and Life cycles of plants (20 hrs)

1. Definition and significance of Reproduction. Brief account on reproduction of prokaryotic and eukaryotic cells. A comparative account on reproduction among different Fungal groups.
2. Types of reproduction with examples- vegetative, asexual and sexual reproduction. Importance of reproductive methods in identification and classification of plants. General Account on Vegetative methods with examples: Buds, Bulbils, Fragmentation; Asexual reproduction with examples- Spores- Zoospores, Hypnospores, Chlamydospores.
3. Sexual reproduction- Characteristics and Substages- Gametogenesis and Fertilization. Comparative account on reproduction among different plant groups. Brief account on post fertilization changes. Types of sexual reproduction–Isogamy, Anisogamy and Oogamy with examples.
4. Different Life cycles -haplontic diplontic, haplodiplo biontic life cycles.

Module 2. Diversity of reproduction in Lower plants (8 hrs)

1. Vegetative methods of reproduction among different algal groups.
2. Sexual reproduction in Algae- General and comparative account.
3. Vegetative methods of reproduction among different groups of Bryophytes. .
4. Sexual reproduction in Bryophytes. General and comparative account

Module 3. Diversity of reproduction in Higher plants (7 hrs)

1. Vegetative methods of reproduction among different pteridophyte groups.
2. Sexual reproduction in Pteridophytes- General and comparative account.
3. Vegetative methods of reproduction among different groups of Gymnosperms.
4. Sexual reproduction in Gymnosperms. General and comparative account.

Module 4. Diversity of reproduction in Angiosperms (10 hrs)

1. Vegetative methods of propagation in angiosperms-natural- root stem and leaf as propagules and human intervention- budding, layering, grafting and micropropagation.
2. Sex organs of angiosperms- flower –parts and their function.
3. Brief account on gametogenesis in plants; Types of pollination; Pollen tube growth and fertilization. Brief account on embryo and seed development.
4. Life cycle of angiosperms. Seed- germination-sapling establishment- vegetative growth- flowering – pollination – pollen tube growth – fertilization embryo formation – fruits.

Module 5. TEACH Space (15 hrs):

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Collection of different types of flowers, inflorescence, fruits and seeds.
2. Observation of conjugation in Spirogyra.

3. T.S of mature anther
4. Observation of Dicot embryo and Monocot embryo.
5. Dissection of Embryo from Flower buds
6. Digitalisation of any one -Flower/inflorescence/placentation/flower as a modified shoot/anthers/pollinia or any other
7. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Comparative analysis of different reproductive methods in different plant groups
2. Poster preparation on life cycles of different groups
3. Vegetative propagation methods in various crops

Suggested Assignment Topics- Practical

1. Observe diverse reproductive structure in major plant groups and classification of collected specimens
2. Finding out the mixed characters in the inflorescences of common plants.

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Pandey, S. N. (2009). Plant Anatomy and Embryology. India: Vikas Publishing House Pvt Limited	4
2	Bhojwani, S. S, Bhatnagar, S. P., and Dantu, P. K. (2015). The embryology of angiosperms. Vikas Publishing House	4
3	Singh A K and Kumar A, (2023). Plant Propagation and Nursery management, AK Kataria and Sons.	1, 4
4	Kumar H D and H N Sharma, (1979). A textbook on Algae,	2
5	Vasishta, P. C. (1980). Gymnosperms, S Chand & Co., Ltd., New Delhi	3
6	Sambamurty A. V. S. S., (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International publication, New Delhi.	2, 3
7	Arumugam N, Annie Ragland and V Kumaresan, A textbook of Botany, Saras Publication	1,2, 3, 4
8	Annie Ragland, V Kumaresan and Arumugam N, 2020. A text of Botany-algae, Fungi, Bryophytes, Microbiology and Plant Pathology, Saras Publication.	2, 3
9	Pandey, S. N. & Misra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.	4
10	Vashista, B. R, (1993). Gymnosperms, S Chand & Co., New Delhi.	3
Core Compulsory Readings		
1	Maheshwari, P. (1971). An introduction to the embryology of angiosperms. Tata McGraw Hill Publishing Company Ltd., New Delhi.	
	Vashista, B. R, (1993). Bryophyta, S Chand & Co., New Delhi.	
	Vashista, B. R, (1993). Pteridophyta, S Chand & Co., New Delhi.	
2	Davis W, (2006). Plant Propagation. Read Books.	
Core Suggested Readings		
1	Kains M. G., 2010. Propagation of plants - A complete guide for professional and amateur growers of plants by Seeds, Layers, Grafting and Budding, With Chapters On Nursery And Greenhouse Management, Read Books.	

2	Raven, P.H., Evert, R.F., & Eichhorn, S.E., (2013). Biology of plants. VIIIth Ed. W.H. Freeman Publishers.
3	Starr, C., (2007). Biology : concepts and applications. VI edn. Thomson Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question

- ➢ Discuss the most important two stages in an amphimictic life cycle
- ➢ Define haplontic life cycle and cite an example
- ➢ Draw a neat labeled diagram of mature anther T S

3 Marks Questions (Applying and Analyzing):

- ➢ Comment on 'Flower is a modified shoot'.
- ➢ Compare and contrast Orthotrpus and Anatropus ovules with examples.
- ➢ Distinguish different types of endosperms.
- ➢ Distinguish the lomentum fruit from the legume type.

5 Marks Questions (Evaluating and Creating):

- ➢ Describe megasporogenesis and female gametophyte formation in *Polygonum* with the help of neat labeled diagram.
- ➢ Distinguish different types of Racemose inflorescence with the help of diagrammatic sketches and brief description of salient features of each type.
- ➢ Botanists classify inflorescences into three or four types. Nature doesn't obey our classification rules. Substantiate the two statements.

Employability for the Course / Programme

It is one of the basic courses which is very helpful in understanding the fundamental concepts in cell biology as well as in diversity of lif

44	Angiosperm Taxonomy and Morphology	KU2DSCBOT106
Semester : 2 **Hrs/week: 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 200-299 level
2. Ability to write examination in Englis**h**

Course Outcomes	
CO1	Understanding of the fundamental concepts in morphological characters and classification of Angiosperms.
CO2	Concept development in diversity that exist in angiosperms through studies in vegetative and floral morphology.
CO3	Enable the student to classify different types flower, inflorescences, fruits and seeds.
CO4	Skill in comparison by observing the features, both vegetative and reproductive, and thereby classification of angiosperms.
CO5	Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/entrepreneurship

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√							
CO3			√				√					
CO4								√	√			
CO5											√	√

Course Description
This is an introductory biology course designed for UG students in general and BSc Zoology BSc Microbiology and BSc Forestry in particular. The aim of the course is to give basic knowledge about the diversity of plant life forms.
• *First module deals with the reproduction and life cycles of plants.* • *Second module focuses on the reproduction algae and bryophytes.* • *Third module gives an idea on the reproduction of pteridophytes and gymnosperms.* • *Fourth module delves into the reproduction in angiosperms.*
This course will also provide opportunities to observe and experience diverse forms of plant reproduction through various laboratory sessions.

Course Objectives:

1. Understanding of the fundamental concepts in reproduction and life cycle of plants.
2. Concept development in diversity of general growth and development plants.
3. Enable the student to appreciate bio diversity.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/enterpreneurship

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Vegetative morphology 5 Hrs Root- Types of roots and brief account on modifications Stem- Types of stem and brief account on modifications
Leaf - simple, compound; venation and phyllotaxy and brief account on modifications

Module 2. Reproductive Morphology 8 hrs
Inflorescence: racemose, cymose and special types
Flower as a modified shoot, structure of flower - floral parts, their arrangement, relative position; cohesion and adhesion of floral parts, symmetry of flowers; types of aestivation and placentation; floral diagram and floral formula.

Module 3. Angiosperm Classification 7 Hrs
Systems of classification Artificial, Natural of Phylogenetic (Brief account only).
Nomenclature-Binomial system of nomenclature, ICBN (Brief account only)
Bentham & Hooker's system of classification (Up to series) and its merits and demerits.
Herbarium technique. Significance of herbaria and botanical gardens; important herbaria and botanical gardens in India.

Module 4. Representative Angiosperm Families 15 Hrs
Study the following families of Bentham and Hookers system of classification with special reference to major identifying characters and economic importance.
Annonaceae, Malvaceae, Fabaceae (with special emphasis to Subfamily Papilionoidiae, two others mention only), Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Euphorbiaceae, Orchidaceae. Evolutionary significance of the families studied
Primitive and advanced characters of the families mentioned above. Evolutionary significance of Angiosperms-relationship with gymnosperms

Module 5. TEACH Space (15 hrs):
This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.
1. Identify different types of inflorescences and fruits included in the syllabus by affixing photographs in the record
2. Learning family characteristics by demonstrations in the laboratory using one typical plant from each family Annonaceae, Malvaceae, Fabaceae (with special emphasis to Subfamily Papilionoidiae), Rubiaceae, Asteraceae, Apocynaceae, Solanaceae and Euphorbiaceae
3. Learning to describe plants in technical terms identifying the family to which the plant belongs.
4. Each student shall submit 10 herbarium specimens belonging to the families included in the syllabus & field book for evaluation
5. Documentation of the practical works – videos, microscopic photo, diagrams and photographs

into a record book.

Suggested Assignment Topics- Theory

1. Comparative analysis of different reproductive methods in different plant groups
2. Poster preparation on life cycles of different groups
3. Vegetative propagation methods in various crops

Suggested Assignment Topics- Practical

1. Observe diverse reproductive structure in major plant groups and classification of collected specimens
2. Finding out the mixed characters in the inflorescences of common plants.

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Gangulee, S.C., Das, K.S., Dutta, C.D., & Kar, A.K., (1968). College Botany Vol. I, II and III. Central Education Enterprises	1,2, 3, 4
2	Baruah A, 2023. Angiosperm Taxonomy, Asian Humanities Press	3, 4
3	Gupta R.K. (1981). A Text Book of Systematic Botany, Atma Ram & Sons, Delhi	3, 4
4	Tewari L M and Jeewan S. Jalal (2011). Flowering Plants- Angiosperms, Jagdamba Publishing Company, New Delhi.	1, 2, 3,4
5	Harris JG and M W Harris, 2001. Plant Identification Terminology: An Illustrated Glossary, Spring Lake Publishers	1, 2, 3, 4
6	Ragland A and V Kumaresan, Angiosperms,Saras Publication	2, 3
7	Pandey, S. N. & Misra, S. P. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.	3, 4
8	Singh V, Pande P C and D K Jain, 2019. Taxonomy of Angiosperms, Rastogi Publications.	3
Core Compulsory Readings		
1	Gifford, E.M., & Foster, A.S., (1988). Morphology and Evolution of Vascular Plants. W.H. Freeman & Company, New York	
2	Simpson M G, (2019). Plant Systematics, Academic Press.	
3	Sharma ,O.P. (2010). Plant Taxonomy, The Mc Graw Hill Companies	
Core Suggested Readings		
1	Douglas, E. & Soltis *et al*. (2005). Phylogeny and Evolution of Angiosperms. Sinauer Associates Inc.	
2	Kitching, I.J. *et al*. (1998). Cladistics – the theory and practice of Parsimony Analysis. Oxford University Press.	

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**

• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question
- What are the major features of polypetalae?
- Define aestivation
- Name any two phyllotaxy with appropriate examples.
- Expand ICBN

3 Marks Questions (Applying and Analyzing)
- Flower is a modified shoot. Substantiate with the help of any four features.
- Position of gymnosperm in Bentham and Hookers' classification is found to be less significant. Apply the concepts of primitive and advanced characters in pheanerogams to substantiate the statement.
- How does herbaria preparation helps in plant taxonomy?

5 Marks Questions (Evaluating and Creating):
- Tubers are different in its morphology. Critically evaluate this statement.
- Asteraceae is having several advanced and primitive characters. Classify the characters of asteraceae to advanced and primitive; in a tabular form.

Employability for the Course / Programme

It is one of the basic courses which is very helpful in understanding the fundamental concepts in cell biology as well as in diversity of life

45	Diversity of Plants II	KU3DSCBOT206
Semester : 3 **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 100-199 level.
2. Completed the course Diversity of Plants I
3. Ability to write examination in English

Course Outcomes	
CO1	Acquisition of basic knowledge in the diversity among life forms, especially on plants.
CO2	Understanding of the terms used in the description of diverse forms of life.
CO3	Understanding the basic differences that exist among different groups of plants.
CO4	Ability to apply the concepts gathered in this course to the field of evolution and advanced diversity and ecological studies.
CO5	First-hand experience in viewing the diversity using laboratory procedures and there by induction of enthusiasm in biological studies.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1V	√	√	√									
CO2			√	√	√							
CO3				√	√	√						
CO4								√	√			
CO5										√		√

Course Description
This is an intermediate biology course designed for UG students in general and BSc Zoology BSc Microbiology and BSc Forestry in particular. The aim of the course is to give basic knowledge about the diversity of plant life forms.
• *First module gives an idea on reproduction and lifecycle of algae through type organism studies.* • *Second module focuses on the features and life history of selected fungal taxa.* • *Third module is a discussion on bryophytes and pteridophytes, with an emphasis to reproduction and life cycle.* • *Fourth module is dealing with the reproductive structure and life cycle of gymnosperms.*
This course will also provide you opportunities to observe diverse cells and hands-on training to identify stages of mitosis and meiosis during laboratory sessions.

Course Objectives:

1. Understanding of the fundamental concepts in description of plants.
2. Concept development in structure and reproduction of lower groups of plants.
3. Enable the student to appreciate biodiversity.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/entrepreneurship

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Algae (15 hrs)

Reproduction and life history of the following groups with reference to the types mentioned (Excluding the developmental stages).

a) Cyanophyceae – *Nostoc*
b) Chlorophyceae –*Volvox*, *Spirogyra* and *Chara.*
c) Phaeophyceae – *Sargassum*
d) Rhodophyceae – *Polysiphonia*

Module 2. Fungi (10 hrs)

General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned:

a) Zygomycotina – *Rhizopus*
b) Ascomycotina – *Penicillium*
c) Basidiomycotina – *Agaricus*

Module 3. Bryophytes and Pteridophytes (12 hrs)

General characters and classification -Morphology, anatomy, reproduction and life cycle of *Riccia* and *Funaria.*
General characters - Structure and reproduction of *Selaginella* and *Nephrolepis*

Module 4. Gymnosperms (8 hrs)

General characters - Structure and reproduction of *Cycas and Pinus*

Module 5. TEACH Space (15 hrs):

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Identification of the vegetative & reproductive structures: Cyanophyceae – *Nostoc;* Chlorophyceae –*Spirogyra* and *Chara;* Rhodophyceae – *Polysiphonia*; *Selaginella; Cycas*
2. Study of vegetative structures – *Volvox* colony, *Sargassum* lateral, *Riccia* thallus, *Cycas* Leaflet TS
3. Study of reproductive structures – *Spirogyra* lateral and scalariform conjugation; *Rhizopus* zygospore and sporangiospore; *Agaricus* Basidiocarp entire and Gill TS, *Nephrolepis* sporophyll T S, *Cycas* sporophylls (entire), *Pinus* male and female cones (entire).
4. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Thallus structure in algae
2. Cell Structure and Pigments in mentioned algal genera

3. Lifecycle in algae with examples
4. Morphological variation in bryophytes
5. Variation in Reproduction among fungi
6. Leaf structure in Pteridophytes
7. Distribution of Gymanosperms
8. Fossil gymnosperms
9. Poster presentation in Life cycle of Algae, Archegoniates and Fungi.

Suggested Assignment Topics- Practical

1. Fungal culture and collection
2. Bryophyte collection
3. Variation in Sporangium and sporophyll of ferns
4. Collection of algae from ponds

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Bilgrami K S and L C Saha, (2020). A Textbook of Algae,Athithi Books.	1
2	Sundararajan S, (2023). Introduction to Algae, V M Books	1
3	Singh, V, Pande P C and D K Jain, (2017). Archegoniate (bryophyta, pteridophyta & gymnosperms), Rastogi Publications.	2, 3, 4
4	Yadav, S.,2022. Archegoniate with practical, Mahaveer Publications.	2,3, 4
5	Singh, V, Pande P C and D K Jain, (2022). Botany Archegoniates And Plant Architecture, Rastogi Publications	2, 3, 4
6	Sirka, Y., (2021). An Introduction to Archegoniate Plants: Bryophytes, Pteridophytes and Gymnosperms, Academic Aspirations.	2, 3, 4
Core Compulsory Readings		
1	Pandey, A, Malhotra, S, Shukla, K, Husain, M, Saxena, S, (2023). Plant architecture: insights from Archegoniate, Book Saga Publications.	
2	Acharya, B C, (2020). Archegoniates, Kalyani Publishers.	
Core Suggested Readings		
1	Vanderpoorten, A and B Goffinet, (2009). Introduction to Bryophytes, Cambridge University Press.	
2	Price D and C Bealey, (2022). A field guide to Bryophytes, Species Recovery Trust.	

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments ➢ Collaborative learning-Group Discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question

- What is meant by stele? Give an example for polystele from Pteridophytes.
- Give a short note on heterospory with an example.
- Differentiate elaters from spores
- List out any four reserve food materials specific to algal groups.

3 Marks Questions (Applying and Analyzing):

- Amphibians are having the ability to live in two types of habitats. Comment on amphibious nature of bryophytes.
- Comment on the peculiarities of *Polysiphonia* life cycle.
- Write short note on different life cycles in algae.

5 Marks Questions (Evaluating and Creating):

- Critically analyze the characters of *Cycas* and comment on the xerophytic nature.
- Give a comparative account on reproductive structures in fungi.

Employability for the Course / Programme

It is one of the basic courses which is very helpful in understanding the fundamental concepts in biology as well as in daily life

46	Angiosperm Anatomy and Embryology	KU3DSCBOT207
Semester : 3 Hrs/week : 3 Theory + 1 Practical		Credits : 4

Course Pre-requisite:

1. Knowledge in Biology at 200-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Knowledge in the internal structure of angiosperm.
CO2	Understanding of the anatomical, palynological and embryological related terms used in the description of diverse forms of life.
CO3	Understanding the variations in the internal structure and reproduction that exist in various plant groups.
CO4	Interpret the adaptive and protective mechanisms exhibited by plants in response to various environmental conditions.
CO5	Ability to apply the concepts in the field of evolution and diversity studies.
CO6	Firsthand experience in viewing cells under microscope and there by induction of enthusiasm in biological studies.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1V	√	√	√									
CO2			√	√	√							
CO3				√	√	√						
CO4								√	√			
CO5										√		√

Course Objectives

1. Understand plant tissue classification, structure, and functions.
2. Explore plant anatomy, including primary structures and tissue systems.
3. Study plant reproduction mechanisms and embryology.
4. Develop practical skills in observing and analyzing plant structures and tissues.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Tissues 10 Hrs

Tissues – meristematic and permanent; classification of meristems based on position, origin; Organization of shoot apex and root apex- Histogen theory & Tunica corpus theory. Simple and complex tissues, secretory tissues (nectarines and hydathodes). Vascular bundles – types: conjoint collateral, bicollateral, concentric and radial.

Module 2. Anatomy of root, stem and Leaf 10 Hrs

Primary structure of monocots and dicots –root, stem and leaf. Secondary thickening in dicot stem and dicot root. Anomalous secondary thickening in *Boerhaavia.* Heart wood and sap wood; tyloses; hard wood and soft wood; growth rings, dendrochronology.

Module 3. Embryology 15 Hrs

Introduction and Historical account of Embryology.
Structure and functions of Microsporangium and wall layers. Microsporogenesis and development of male gametophyte.
Megasporogenesis and development of female gametophyte (*Polygonum*, *Allium* and
Peperomia). Types of ovules.
Pollination-mechanism. Fertilisation. Endosperm – structure, development and types (Nuclear, Cellular, Helobial, Special type – Ruminate). Embryo – Structure and development of Dicot embryo, Monocot embryo. Polyembryony- Classification and Significance, Apomixis, Agamospermy- Apospory and Parthenocarpy.

Module 4. Fruits, Seeds and Palynology 10 Hrs Fruits-classification- simple, aggregate and multiple Seeds – Definition, Types, Structure and germination.
Palynology - Pollen structure and Morphology, Acetolysis of pollen grain. Economic importance, Pollen allergy.
Plant animal Interaction in pollination and seed dispersal. Co-evolution of plants and insects, Role of Plant-Animal interactions in sustainability of ecosystem. Brief account of myrmecophily, chiropterophily.

Module 5. TEACH Space (15 hrs):
This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.
1. Observation of apical meristems in root and stem.
2. Microphotographs of different types of tissues- Parenchyma- Aerenchyma, Chlorenchyma (Spongy, Palisade), Collenchyma, Sclerenchyma, Xylem and Phloem
3. Microphotographs of different types of tissue systems- trichomes, stomata- Dicot and Monocot
4. Primary structures in dicot stem (*Centella*), root (*Tinospora*), and leaf (*Ixora*) and monocot stem (Grass), root (*Colocasia*), and leaf (Grass).
5. Secondary Structures in Dicot root (*Tinospora*) and Stem (*Vernonia*)
6. Anomalous secondary thickening in *Boerhaavia* stem.
7. TS of Mature anther- *Datura, Ixora*
8. Observation of Pollinia- *Calotropis*/ Orchids
9. Embryos of Monocots and Dicots
10. Documentation of the practical works – videos, microscopic photo

Suggested Assignment Topics- Theory
1. Comparative analysis of different reproductive methods in different plant groups
2. Poster preparation on life cycles of different groups
3. Vegetative propagation methods in various crops

Suggested Assignment Topics- Practical
1. Observe diverse reproductive structure in major plant groups and classification of collected specimens
2. Finding out the mixed characters in the inflorescences of common plants.

Suggested readings specific to the module.		
Sl. No	Title/Author/Publishers of the Book specific to the module	Module No.
1	Pandey, S. N. (2009). Plant Anatomy and Embryology. India: Vikas Publishing House Pvt Limited	1, 2, 3
2	Bhojwani, S. S, Bhatnagar, S. P., and Dantu, P. K. (2015). The embryology of angiosperms. Vikas Publishing House	3
3	Pandey, B P, (2001). Plant Anatomy, S Chand Publications	1,2, 3
4	Siddiqui G A, (2012). Plant Anatomy, Pragun Publications.	2
5	Rudall, P A, (2020), Anatomy of Flowering Plants An Introduction to Plant Structure and Development, Cambridge University Press.	4
6	Spjut, R. W, (1994). A Systematic Treatment of Fruit Types, The Newyork Botanical Garden.	4
7	Dutta A C, 1964. A Class Book of Botany, Oxford University Press	1,2, 3, 4
8	Gangulee, H C and A K Kar, 2011. College Botany- Volume I, II, III New Central Book Agency (P) Ltd.	1,2, 3, 4
Core Compulsory Readings		
1	Maheshwari, P. (1971). An introduction to the embryology of angiosperms. Tata McGraw Hill Publishing Company Ltd., New Delhi.	
2	Crang, R, S L Sobaski and R, Wise, (2018). Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants, Springer.	
3	Davis W, (2006). Plant Propagation. Read Books.	
Core Suggested Readings		
1	Kains M. G., (2010). Propagation of plants - A complete guide for professional and amateur growers of plants by Seeds, Layers, Grafting and Budding, With Chapters On Nursery And Greenhouse Management, Read Books.	
2	Raven, P.H., Evert, R.F., & Eichhorn, S.E., (2013). Biology of plants. VIIIth Ed. W.H. Freeman Publishers.	
3	Starr, C., (2007). Biology: concepts and applications. VI edn. Thomson Press.	

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

Marks Question

➢ Discuss the most important two stages in an amphimictic life cycle

- Define haplontic life cycle and cite an example
- Draw a neat labeled diagram of mature anther T S

3 Marks Questions (Applying and Analyzing):

- Comment on ’Flower is a modified shoot’.
- Compare and contrast Orthotrpus and Anatropus ovules with examples.
- Distinguish different types of endosperms.
- Distinguish the lomentum fruit from the legume type.

5 Marks Questions (Evaluating and Creating):

- Describe megasporogenesis and female gametophyte formation in *Polygonum* with the help of neat labeled diagram.
- Distinguish different types of Racemose inflorescence with the help of diagrammatic sketches and brief description of salient features of each type.
- Botanists classify inflorescences into three or four types. Nature doesn’t obey our classification rules. Substantiate the two statements.

Employability for the Course / Programme

It is one of the basic courses which is very helpful in understanding the fundamental concepts in cell biology as well as in diversity of life

47	Forest Botany	KU3DSCBOT208
Semester : 3 **Hrs/week : 3 Theory + 1 Practical**		**Credits : 4**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Completed the minor courses in the first two semesters
3. Ability to write examination in English

Course Outcomes

CO1	Knowledge in the basic concept and principles of forest botany.
CO2	Understanding the fields of application of botanical knowledge in the field of botan
CO3	Understanding the plant adaptations in forest ecosystem with an emphasis to Western Ghats.
CO4	Interpret the adaptive and protective mechanisms exhibited by plants in response to various environmental conditions.
CO5	Ability to apply the concepts in the field of evolution and diversity studies.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√							
CO3				√	√	√						
CO4								√	√			
CO5										√		√

Course Description
This is a comprehensive course designed for UG students in general and BSc Zoology and BSc Forestry in particular for understanding the applications of botany in understanding forest ecosystems. It covers taxonomy and morphology of forest plants that equips students for sustainable forest management. The aim of the course is to give basic knowledge about the diversity of plant life forms.
• *First module gives glimpses of forestry and its relation with botany.* • *Second module is an account on flora of Western Ghats and their adaptations.* • *Third module emphasizes on forest trees of Western Ghats.* • *Fourth module delves into the utilitarian aspect of forests.*
This course will also provide opportunities to observe diverse forms of plant life in forests and will help in future entrepreneurship.

Course Objectives:

1. Understanding of the fundamental concepts in forest botany.
2. Concept development in basic structure and reproduction of forest plants.
3. Enable the student to appreciate bio diversity, sustainable development with the help of their core subject and subsidiary subject botany.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/enterpreneurship

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25T+10P)	65 (50T+ 15P)	100

COURSE CONTENT

Module 1. Introduction to forestry 10 Hrs

Definition, role direct and indirect benefits. General account on forest types in the World. Classification, Status and distribution of forests, with special reference to India. Comparative primary productivity of different types of forest ecosystems in the world. Basic concepts on Forest types of India and Kerala Champion & Seth Revised system of classification

Module 2. Diversity of plants in forests in Western Ghats 10 Hrs

Types of plant forms in tropical rain forests-Trees, Herbs, Shrubs, Creepers, Lianas, Twiners, Epiphytes. Annuals, Biennials, Perennials. Major plant groups- bryophytes, Pteridophytes, gymnosperms and angiosperms. Adaptation in forest environment- Structure of leaves, stem wood , bark and roots in trees, Adaptations with special reference to shade tolerance, leaf modifications, Root systems, seed dispersal mechanisms , epiphytic adaptations and mycorrhiza associations

Types of woody plants. Comparative wood anatomy of gymnosperms and angiosperms. Soft wood and hardwood. Dendrochronology and Dendroclimatology.

Module 3. Major forest trees of Western Ghats 10 Hrs

Concept of Endemic and RET plants. Significance, Threats and consequences of loss. Red data book, An overview of major RET and Endemic trees of Western Ghats. Role of vegetative characters in identification of forest trees- the bole, buttresses, flute, leaf characters, colour of younger and older leaves, characteristic of bark, blaze and exudations. Tree identification and classification based on morphology of stem and leaves and architecture. Tree forms, shapes and architecture. Importance scope of dendrology

Module 4. Useful Forest products and plants 10 Hrs

Major Timbers, Non timber forest products- bamboo and canes, resins, tannins, honey, Forest products and their utilization in industries and entrepreneurships An overview of Gadgil Committee Report, Oommen V Ommen report.

Module 5. TEACH Space 15 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Collection of forest products.
2. Visit to forest area and document the diversity.
3. Collect news and photographs regarding the forest.
4. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Vegetation types of India
2. Types of products and their documentation

Suggested Assignment Topics- Practical

1. Microphotographs of all practical works
2. Collection documentation and classification of diverse forms of plant life in forestry.

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Shanmughavel P, 2014. Forest Botany, Pointer Publishers	1, 2, 3,4
2	Negi S S, 2012. Forest Botany, Bishen Singh Mahendrapal Singh	1, 2, 3, 4
3	Sarmah D, 2024. Distribution of trees across the Western Ghats in Karnataka, Notion Press.	2, 3, 4
4	Pullaiah, T., 2024. Biodiversity Hot Spots of the Western Ghats and Srilanka, CRC Press.	2,3
5	Mukherjee, P, 2016. Flora of the Southern Western Ghats and Palnis, Niyogi books.	2, 3
6	Bor, N. L. (1953). Manual of Indian forest botany. Manual of Indian forest botany.	2, 4
7	Sivanna, H, 2012. Handbook on Forest Biology, Discovery Publishing House	1, 2, 3, 4
8	Raj, A J., 2013. Forestry Principles And Applications, Scientific Publishers	1,2, 3,4
Core Compulsory Readings		
1	Grebner D.L., 2024. Introduction To Forestry and Natural Resources, Elsevier.	
2	Burton, L D, 2019. Introduction To Forestry Science, Cengage India.	
Core Suggested Readings		
1	Sterck, F., & Turnbull, C. (2005). Woody tree architecture. Annual Plant Reviews, Plant Architecture and its Manipulation, 17, 210-237.	
2	FAO. (2015). *Global Forest Resources Assessment*. Rome: FAO of United Nations.	

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Sample Questions to test Outcomes.

2 Marks Question

➢ Define Forest Botany

- Give the botanical name and peculiarities of good timber
- Expand RET. Give an example from Western Ghats
- Differentiate Woods from forests

3 Marks Questions (Applying and Analyzing):

- Analyse the major reasons to consider Western Ghats as Biodiversity hot spot?
- List out the major reasons for the deterioration of Western Ghats and explain.

5 Marks Questions (Evaluating and Creating):

- Critically comment on Gadgil Committee Report and Add a note on the strategies that can be used to manage Western Ghat's biodiversity.
- Give a detailed account on different landscapes and forest types present in Western Ghats.

Employability for the Course / Programme

It is one of the advanced courses which is very helpful in understanding the diversity of plant life

48	Mycology, Phytopathology and Applied Botany		KU6DSCBOT321
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Completed any two Botany/Plant Science during under graduation at 201-299 level
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Classify fungi based on morphology, reproduction, and evolutionary relationships.
CO2	Analyze the roles of fungi in ecosystems, agriculture, and disease causation.
CO3	Diagnose common fungal diseases and recommend appropriate management strategies.
CO4	Demonstrate understanding of fungal biotechnology and industrial applications.
CO5	Integrate fungal knowledge into applied research, sustainable agriculture, and environmental conservation.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√										
CO2					√	√						
CO3							√	√		√		
CO4								√		√	√	
CO5									√	√	√	√

Course Description

This course provides an in-depth understanding of fungi—their diversity, structure, reproduction, ecological significance, and economic roles.

- *First module is dealing with This module introduces the fascinating world of fungi, emphasizing their unique characteristics, habitats, nutrition, and reproduction.*
- *Second module examines the structure, reproduction, and life cycles of major fungal groups—Zygomycotina, Ascomycotina, and Basidiomycotina.*
- *Third module introduces the science of plant pathology and its importance in crop health and productivity.*
- *Final module focuses on the practical and industrial applications of fungi in agriculture and biotechnology..*

Students will gain knowledge of fungal diseases of crops, mechanisms of infection, and sustainable disease management strategies.

Course Objectives:

1. Understand the fundamental characteristics, diversity, and classification of fungi.
2. Explain the structure, reproduction, and life cycles of major fungal groups.
3. Identify important plant pathogens and describe mechanisms of plant disease development.
4. Evaluate the ecological, agricultural, and industrial significance of fungi.
5. Apply knowledge of fungal biology to develop sustainable and biotechnological solutions in agriculture and industry.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 1 (45+ 0 + 30)	3	35	65	100

COURSE CONTENT

Module 1: Diversity and Classification of Fungi 10 Hours

1.1. General Characteristics of Fungi: Salient features, Habitats and distribution, nutrition-saprophytic, parasitic, and symbiotic. Growth forms and Types of fungal cell wall, Modes of reproduction – asexual (spores, conidia, budding, fragmentation) and sexual (gametangial contact or fusion).

1.2. Classification of Fungi – Ainsworth's System (1973): Overview of major divisions: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina.

1.3.Thallus Organization and Fruiting Bodies: Variations in fungal body structure: unicellular (yeast), filamentous (molds), coenocytic and septate mycelia. Fruiting body structures: *Ascocarps* (in Ascomycetes) – cleistothecium, perithecium, apothecium. *Basidiocarps* (in Basidiomycetes) – mushrooms, brackets. Associated structures like *ascogonium*, *ascothecium*, and reproductive spores. Functional significance of these structures in reproduction and dispersal.

1.4 Economic and Ecological Importance: Beneficial roles: decomposition, nutrient recycling, mycorrhizae, antibiotics, fermentation, food (mushrooms). Harmful aspects: plant diseases, spoilage of food, mycotoxins, and human infections. Ecological roles: fungal symbioses, biodegradation, and soil ecosystem balance.

Module 2: Diversity in Major Fungal Groups 9 Hours

2.1 Zygomycotina – *Rhizopus*- Vegetative, reproductive features and Life cycle of *Rhizopus stolonifer* (bread mold).Economic importance.

2.2 Ascomycotina – *Penicilliums*- Vegetative, reproductive features and Life cycle. Economic importance: source of *Penicillin*, cheese ripening, and biotechnological uses.

2.3 Basidiomycotina – *Agaricus*- Vegetative, reproductive features and Life cycle.

2.4 Comparative Study of Fungal Groups: Comparative overview of Zygomycotina, Ascomycotina, and Basidiomycotina.

Module 3: Fundamentals of Plant Pathology 9 Hours

3.1 Introduction to Plant Pathology: Definition, scope, and historical milestones of plant pathology. Importance in crop protection and yield management. Concept of disease: symptoms vs. signs; disease triangle (host–pathogen–environment).

3.2 Causes and Mechanisms of Plant Diseases: Pathogens: fungi, bacteria, viruses, nematodes, and abiotic causes (nutrient deficiency, temperature, pollutants). Mechanisms of infection: entry, colonization, and symptom development. Host–pathogen interaction: susceptibility, resistance, hypersensitive response.

3.3 Major Fungal Diseases of Crops: Symptomatology, pathogen morphology, life cycle, and control measures of the following diseases: *Late blight of potato* (*Phytophthora infestans*), *Red rot of sugarcane* (*Colletotrichum falcatum*), Rust disease of Wheat (*Puccinia graminis var. triticii*). *Tikka disease of groundnut* (*Cercospora personata*).

3.4 Disease Management Principles: Cultural control: crop rotation, sanitation, resistant varieties.Chemical control: fungicides, dosage, and application.Biological control: antagonistic fungi (*Trichoderma*, *Gliocladium*). Integrated Disease Management (IDM): sustainable, ecosystem-based approach.

Module 4. Applied Botany and Agricultural Applications of Fungi 8 Hours

4.1 Fungi in Agriculture: Role in soil fertility: decomposition, nutrient cycling, and humus formation. Mycorrhizal associations (VAM, Ectomycorrhizae) improving nutrient uptake and

drought tolerance. Saprophytic fungi in composting and organic waste degradation.
4.2 Fungal Biofertilizers and Biocontrol Agents: Biofertilizers: fungal inoculants enhancing plant growth (e.g., *Glomus*, *Rhizophagus* species). Biocontrol agents: *Trichoderma*, *Aspergillus*, *Beauveria* controlling soil-borne pathogens and insect pests.
4.3 Industrial Applications of Fungi: Fermentation industries: alcohol (*Saccharomyces*), citric acid (*Aspergillus niger*), enzymes, and organic acids. Pharmaceuticals: antibiotics (*Penicillin*), immunosuppressants (*Cyclosporin*). Food industry: mushrooms, yeast, cheese, soy sauce, and fermented beverages.
4.4 Recent Advances in Applied Botany: Fungal biotechnology: genetic engineering for enhanced metabolite production. Tissue culture applications: fungal elicitors in secondary metabolite production. Sustainable fungal technologies: biofungicides, waste bioconversion, and carbon sequestration by fungi.

Module 5. TEACH SPACE 9 Hrs
This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.
Theory 9 Hrs
Lichens: Nature of association: symbiosis between fungal mycobiont and algal/cyanobacterial phycobiont. Types based on morphology: crustose, foliose, fruticose. Reproduction: by soredia, isidia, and fragmentation. Economic and ecological importance: Dyes (*Rocella*), perfumes, medicines (*Usnic acid*). Bioindicators of air pollution and ecological succession pioneers.
Practical 30 Hrs
1. Study of fungal morphology through permanent slides and fresh specimens — observation of hyphae, mycelium, septa, spores.
2. Identification of fruiting bodies – ascocarps, basidiocarps, cleistothecium, perithecium, apothecium (using charts or slides).
3. Microscopic observation of common saprophytic fungi (e.g., Mucor, Aspergillus).
4. Demonstration: Preparation of temporary mounts and staining of fungal spores.Study of Zygomycotina: Rhizopus stolonifer – vegetative structure, sporangia, zygospore.
5. Study of Ascomycotina: Penicillium – conidiophores and conidia.
6. Study of Basidiomycotina: Agaricus – external and internal structure of mushroom (pileus, gills, basidia, basidiospores).
7. Comparison chart of the three groups – highlighting life cycles, reproduction, and fruiting structures.
8. Spotting/slide identification: Various fungal reproductive structures.
9. Observation and identification of disease symptoms on preserved or fresh specimens of the diseases mentioned above.
10. Industrial uses of fungi – slides or charts showing fermentation (yeast, *Aspergillus niger*).
11. Preparation of mushroom culture substrate (demonstration).

Suggested Assignment Topics- Theory
1. Beneficial role of Fungi
2. Fungal diseases of Major crops of North Kerala
3. Fungal diseases of Human
4. Identification features of fungi

Suggested Assignment Topics- Practical
1. Fungal spore staining
2. Fungal collection
3. Fungal culture using PDA

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Agrios, G. N. (2005). *Plant Pathology* (5th ed.). Elsevier Academic Press.
2	Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory Mycology* (4th ed.). Wiley.
3	Bilgrami, K. S., & Verma, R. N. (1981). *Physiology of Fungi*. Vikas Publishing House.
4	Carlile, M. J., Watkinson, S. C., & Gooday, G. W. (2001). *The Fungi* (2nd ed.). Academic Press.
5	Cooke, R. C., & Rayner, A. D. M. (1984). *Ecology of Saprotrophic Fungi*. Longman.
6	Deacon, J. W. (2006). *Fungal Biology* (4th ed.). Blackwell Publishing.
7	Dix, N. J., & Webster, J. (1995). *Fungal Ecology*. Chapman & Hall.
8	Dube, H. C. (2019). *An Introduction to Fungi* (5th ed.). Scientific Publishers.
9	Garrett, S. D. (2012). *Plant Pathology*. Cambridge University Press.
10	Gupta, R. (2014). *Applied Mycology and Biotechnology*. Springer.
11	Mandahar, C. L. (2018). *Introduction to Plant Pathology*. CRC Press.
12	Mehrotra, R. S., & Aneja, K. R. (2017). *An Introduction to Mycology* (4th ed.). New Age International.
13	Mukerji, K. G., Manoharachary, C., & Singh, J. (2009). *Fungal Diversity and Biotechnology*. I. K. International.
14	Prescott, L. M., Harley, J. P., & Klein, D. A. (2005). *Microbiology* (6th ed.). McGraw-Hill.
15	Sharma, P. D. (2021). *Mycology and Plant Pathology* (12th ed.). Rastogi Publications.
16	Singh, D. P., & Prabha, R. (2015). *Microbial Biotechnology: Fundamentals of Applied Microbiology*. Springer.
17	Singh, R. S. (2002). *Plant Diseases* (8th ed.). Oxford & IBH.
18	Singh, R. S. (2005). *Introduction to Principles of Plant Pathology*. Oxford & IBH Publishing.
19	Tortora, G. J., Funke, B. R., & Case, C. L. (2020). *Microbiology: An Introduction* (13th ed.). Pearson.
20	Webster, J., & Weber, R. (2007). *Introduction to Fungi* (3rd ed.). Cambridge University Press.

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10

• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Practical Examination	10

Employability for the Course / Programme

This course enhances employability in diverse sectors by developing critical understanding and practical skills in fungal biology, plant pathology, and biotechnology.

49	**Evolution of Plants and Animals**	**KU6DSCBOT322**

DSC	Semester: 6	Hrs/week: 4 Theory	Credits: 4

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Explain theories and processes involved in the origin of life on Earth.
CO2	Describe the mechanisms driving evolutionary change and species diversification.
CO3	Identify and analyze various types of evidence supporting evolutionary theory.
CO4	Interpret the geological time scale and relate it to the evolution of major life forms.
CO5	Evaluate evolutionary trends leading to the development of plants, animals, and humans.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√								
CO3									√	√		
CO4								√	√			
CO5									√			√

Course Description
This course explores the scientific understanding of life's origin, the mechanisms of evolution, and the major transitions that shaped biodiversity on Earth.
• *First module is dealing with the scientific quest to understand how life began on Earth.* • *Second module presents the historical development of evolutionary thought, from Lamarck's early ideas to Darwin's theory of natural selection and its modern synthesis.* • *Third module examines the vast body of evidence supporting evolution.* • *Final module integrates geological and biological evolution, outlining Earth's history from the Precambrian to the Cenozoic era..*
Students will study the geological time scale and trace the evolution of plants, animals, and humans with an emphasis placed on integrating molecular, fossil, and ecological evidence to interpret the dynamic history of life.

Course Objectives:

1. Demonstrate understanding of prebiotic chemistry and the early evolution of life.
2. Differentiate between classical and modern theories of evolution and apply them to case studies.
3. Analyze fossil, morphological, and molecular evidence for evolutionary relationships.
4. Relate the geological time scale to key evolutionary and extinction events.
5. Discuss the evolutionary origins and adaptive significance of major plant and animal groups, including humans.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total

4	0	4	4+ 0+ 0 (60 + 0 + 0)	4	30	70	100

COURSE CONTENT

MODULE I: Origin of Life and Major Concepts in Evolution ***(12 Hours)***

1.1 Origin of Life: Abiogenesis vs. Biogenesis; theories on origin of life (Cosmozoic theory, Oparin–Haldane theory, Miller–Urey experiment). Formation of Earth's early atmosphere, synthesis of organic molecules, coacervate theory, evolution of protocells. Prebiotic evolution, RNA world hypothesis, chemical evolution, LUCA (Last Universal Common Ancestor).

1.2 Major Concepts in Evolutionary Biology: Microevolution, macroevolution, speciation, adaptive radiation, convergent and divergent evolution. Mutation, genetic drift, migration, natural selection, and gene flow. Population genetics, gene pool, fitness, selection pressure

1.3 Evolutionary Hierarchy and Complexity of Life: Gradual increase in biological complexity from unicellular to multicellular organisms. Endosymbiotic theory; evolution of eukaryotes and organelles (mitochondria, chloroplasts). Prokaryote–eukaryote transition, multicellularity, symbiogenesis.

1.4 Major Events in Biological Evolution: Origin of photosynthesis, oxygen revolution, origin of sex, colonization of land, Cambrian explosion. adaptive changes enabling transition from aquatic to terrestrial life. Precambrian, Ediacaran fauna, Burgess shale fossils.

MODULE II: Theories and Mechanisms of Evolution ***(12 Hours)***

2.1 Early Theories of Evolution: Lamarckism – Use and disuse theory of inheritance of acquired characters; Weismann's germplasm theory; criticisms.

2.2 Darwinism (Theory of Natural Selection): Variation, struggle for existence, survival of the fittest, natural selection as the main evolutionary force. Differential reproduction, adaptation, speciation by selection.

2.3 Neo-Darwinism (Modernized Darwinism): Integration of genetics with Darwin's ideas; Mendelian inheritance and population variation. Role of mutations, recombination, isolation, and natural selection in evolution.

2.4 Modern Synthetic Theory: Combined framework of Darwinism, genetics, and molecular biology. Evolution as a change in gene frequencies within populations; Hardy-Weinberg equilibrium. Microevolution, macroevolution, adaptive radiation, genetic equilibrium, evolutionary fitness.

MODULE III: Evidence and Documentation of Evolution ***(12 Hours)***

3.1 Morphological and Anatomical Evidences: Homology, analogy, vestigial organs, atavism. Comparative anatomy and embryology as evidence for common ancestry. Divergent and convergent evolution, homologous structures (pentadactyl limb), analogous organs (wings of bat and bird).

3.2 Paleontological Evidences: Fossilization, types of fossils, methods of dating (relative and absolute). Reconstruction of evolutionary history using fossils. Transitional fossils (*Archaeopteryx*, *Tiktaalik*), index fossils, missing links.

3.3 Embryological and Biochemical Evidences: Comparative embryology – von Baer's law, biogenetic law. Study of molecular homologies – DNA, RNA, protein sequencing, immunological similarities. Ontogeny and phylogeny, molecular clock, cytochrome c studies.

3.4 Distributional and Genetic Evidences: Biogeography as evidence of evolution – continental drift, isolation. Genetic and chromosomal studies supporting evolution (karyotype, mutation, recombination). Endemism, adaptive radiation (Darwin's finches), Wallace's line.

MODULE IV: Geological Time Scale and Evolution of Major Plant and Animal Groups ***(12 Hours)***

4.1 Geological Time Scale (GTS): Structure of Earth's history – eons, eras, periods, epochs.

Dating and correlation of strata; interpretation of major biological events. Pecambrian, Paleozoic, Mesozoic, Cenozoic, Phanerozoic, extinction events. 4.2 Origin and Golden Ages of Major Animal Groups: Evolutionary history of major phyla – invertebrates to vertebrates. Cambrian explosion, vertebrate diversification, rise of mammals. Age of Invertebrates (Paleozoic), Age of Reptiles (Mesozoic), Age of Mammals (Cenozoic). 4.3 Evolution of Major Plant Groups: Evolution of algae, bryophytes, pteridophytes, gymnosperms, and angiosperms. Colonization of land, vascularization, seed and flower evolution. Archegoniates, heterospory, seed habit, double fertilization. 4.4 Mass Extinctions and Evolutionary Trends: Major extinction events and their causes (volcanism, asteroid impacts, climate change). Adaptive radiations following extinctions; concept of evolutionary bottleneck. Permian-Triassic extinction, Cretaceous–Paleogene extinction, punctuated equilibrium.
Module 5. TEACH SPACE 12 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5 Hrs** Evolution of Man: Hominid vs. hominin evolution; sequence of human ancestors. Bipedalism, cranial development, tool use, cultural evolution. *Australopithecus*, *Homo habilis*, *Homo erectus*, *Homo sapiens*, Out-of-Africa hypothesis. Evolution of Angiosperms: Origin and radiation of flowering plants; comparative theories. Bennettitales–Caytoniales relationship, fossil records, coevolution with pollinators. Ranalian theory, Magnolian concept, polyphyletic vs. monophyletic origin, Cretaceous radiation. **Practical 7 Hrs** 1. Study of fungal morphology through perm 2. Observation of fossils 3. Types of fossils 4. Bioinformatic tools for cladogram/ phylogenetic tree making

Suggested Assignment Topics- Theory

1. Types of fossils
2. Living fossils vs Fossils
3. Fossilisation process
4. Geological image showing different evolutionary break throughs

Suggested Assignment Topics- Practical

1. Phylogenetic principles and software for cladogram and phylogram preparations
2. Survey for the observation of several evolutionary principles in certain plant groups and animals with evolutionary significance

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Ayala, F. J., & Valentine, J. W. (1979). *Evolving: The Theory and Processes of Organic Evolution*. Benjamin/Cummings.
2	Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B., & Patel, N. H. (2007). *Evolution*. Cold Spring Harbor Laboratory Press.
3	Campbell, N. A., Reece, J. B., & Urry, L. A. (2020). *Biology* (12th ed.). Pearson.
4	Charlesworth, B., & Charlesworth, D. (2010). *Elements of Evolutionary Genetics*. Roberts & Company.
5	Darwin, C. (1859). *On the Origin of Species by Means of Natural Selection*. John Murray.
6	Dawkins, R. (2016). *The Selfish Gene* (40th Anniversary ed.). Oxford University Press.
7	Dobzhansky, T. (1970). *Genetics of the Evolutionary Process*. Columbia University Press.

8	Freeman, S., & Herron, J. C. (2007). *Evolutionary Analysis* (4th ed.). Pearson/Prentice Hall.
9	Futuyma, D. J. (2013). *Evolution* (3rd ed.). Sinauer Associates.
10	Futuyma, D. J., & Kirkpatrick, M. (2017). *Evolution* (4th ed.). Sinauer Associates.
11	Hall, B. K., & Hallgrimsson, B. (2013). *Strickberger's Evolution* (5th ed.). Jones & Bartlett Learning.
12	Huxley, J. (1942). *Evolution: The Modern Synthesis*. George Allen & Unwin.
13	Margulis, L., & Sagan, D. (2002). *Acquiring Genomes: A Theory of the Origins of Species*. Basic Books.
14	Mayr, E. (2001). *What Evolution Is*. Basic Books.
15	Ridley, M. (2004). *Evolution* (3rd ed.). Blackwell Publishing.
16	Simpson, G. G. (1944). *Tempo and Mode in Evolution*. Columbia University Press.
17	Stanley, S. M. (1979). *Macroevolution: Pattern and Process*. W. H. Freeman.
18	Stearns, S. C., & Hoekstra, R. F. (2005). *Evolution: An Introduction* (2nd ed.). Oxford University Press.
19	Strickberger, M. W. (2000). *Evolution* (3rd ed.). Jones & Bartlett.
20	Zimmer, C., & Emlen, D. J. (2015). *Evolution: Making Sense of Life* (2nd ed.). W. H. Freeman.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**70**
• University Examination	70
Continuous Comprehensive Assessment CCA	**30**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical Examination and /or viva voce	10

Employability for the Course / Programme
This course enhances analytical and interpretative skills essential in education, research, biodiversity conservation, environmental management, and biotechnology sectors.

50	**Plantation Management**		**KU6DSCBOT323**
DSC	**Semester: 6**	**Hrs/week: 3 Theory + 1 practical**	**Credits: 4**

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Demonstrate knowledge of plantation establishment, maintenance, and crop profiling.
CO2	Apply scientific and managerial techniques for efficient and sustainable plantation production.
CO3	Manage financial, marketing, and labour aspects of plantations in line with legal and ethical standards.
CO4	Integrate technology, innovation, and sustainability into plantation management systems.
CO5	Design strategies for diversified, resilient, and profitable plantation enterprises.

<u>Mapping of Course Outcomes to PSOs/Pos</u>

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description
This course provides an integrated understanding of the plantation sector, focusing on the biological, managerial, and economic principles underlying plantation agriculture.
• *First module is dealing with the concept of plantation agriculture, distinguishing it from general agriculture and highlighting its economic and ecological relevance.* • *Second module delves into the scientific and technical aspects of plantation crop production.* • *Third module focuses on the economic and business dimensions of plantation management.* • *Fourth module explores advanced and emerging dimensions of plantation systems, focusing on sustainability, diversification, and technological innovation..*
By bridging botany, agronomy, management, and environmental science, this course aims to prepare students for leadership roles in the plantation and agri-business industries.

Course Objectives:

1. Understand the fundamentals, scope, and organizational structure of plantation agriculture.
2. Explain the production technologies, crop management practices, and sustainability considerations in plantations.
3. Analyze the financial, marketing, and logistical aspects of plantation operations.
4. Evaluate the socio-economic, environmental, and legal dimensions of plantation enterprises.
5. Apply strategic, innovative, and sustainable approaches in modern plantation management.

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total

3	1	4	3+ 0+ 1 (45+ 0 + 30)	3	25	50	75

COURSE CONTENT

Module I: Introduction & Fundamentals of Plantation Management (12 Hours): **1.1.Overview of Plantation Sector: D**efinition of plantation agriculture, distinction from general agriculture, scope and scale of plantation crops. Estate, monoculture vs mixed planting. Basic Processes: site-selection, climate & soil requirements, establishing a plantation (layout, spacing, choice of crop). **1.2 Plantation Crops Profiling:** Concepts: major plantation crops in India/Kerala – e.g., tea, coffee, rubber, black pepper, cardamom. Crop propagation (seed, vegetative), nursery management, planting operations, early maintenance. **1.3 Principles of Plantation Management:** Management functions (planning, organizing, leading, controlling) as applied to plantations; estate management. Designing plantation operations schedule, labour management, mechanization, cost control, field operations monitoring. **1.4 Sustainability, Environment & Social-Economics: S**ustainable plantation practices, environmental impact of plantations, biodiversity in plantation systems. Soil erosion, soil conservation, agroforestry, ecosystem services, labour welfare, CSR in plantations. Processes: implementing soil & water conservation measures, integrating shade trees/intercropping, social welfare schemes for plantation workers, certification (e.g., Fairtrade, organic) and compliance.
Module II: Production Technology & Crop Management (12 Hours) **2.1 Soil, Water & Nutrient Management in Plantations:** Concepts: soil types for plantation crops, nutrient requirements, irrigation & moisture management in sloped lands. Terms: pH, CEC (cation exchange capacity), base saturation, micronutrients, fertigation. Processes: soil testing, fertilizer application planning, mulching/cover cropping, water conservation techniques (terracing, contour planting, drip irrigation). **2.2 Crop Establishment and Maintenance:** plantation establishment phases, growth phases of plantation crops, maintenance operations. primary planting, rejuvenation planting, spacing, pruning, shade regulation.Processes: land preparation, planting operations, regular maintenance (weeding, shade management, training and pruning), rejuvenation of old blocks. **2.3 Pest, Disease and Weed Management in Plantations:** Concepts: common pests/diseases/weeds in plantation crops, integrated pest management (IPM) adapted to plantations. Terms: pest threshold, biological control, fungicide, herbicide, weeds, epiphyte, shade-tolerant weed species. Processes: pest/disease monitoring, selection of control methods (cultural, biological, chemical), application timing and record-keeping, weed management strategies in plantation contexts. **2.4 Harvesting, Post-Harvest & Processing in Plantation Crops:** harvesting methods appropriate for plantation crops, primary processing on-site, value addition and quality control. plucking standard, tippiness (tea), tapped latex (rubber), bean fermentation (coffee), grading, traceability. scheduling harvesting cycles, on-estate processing steps, quality grading, storage and transport logistics, ensuring minimal waste/loss in plantation produce.
Module III: Business, Marketing and Value Chain of Plantation Produce (12 Hours) **3.1 Economics & Financial Management for Plantations:** Costing, budgeting, productivity measurement, profitability in plantation enterprises.Terms: fixed cost, variable cost, break-even analysis, yield per hectare, EBITDA, ROI (return on investment). Processes: preparing budget for a plantation block, analysing cost-benefit of rejuvenation or alternative crops, financial record-keeping, risk assessment (weather, labour, market). **3.2 Marketing, Supply Chain and Export of Plantation Crops:** Concepts: domestic & international markets for plantation crops, supply chain logistics, export regulations, commodity boards. Terms: auction system (tea/coffee), FOB price, value chain, traceability, commodity board (e.g., Tea Board of India). Processes: understanding marketing channels, packaging, branding of plantation produce, export documentation, logistics (storage, transport, cold chain if needed), stakeholder coordination. **3.3 Technology, Innovation & Mechanization in Plantations:** Concepts: role of mechanization and technology adoption in plantation management, precision farming in plantations, remote sensing/GIS applications. Terms: mechanised harvester, GPS mapping, yield mapping, plantation management

software, drone monitoring. Processes: selecting appropriate mechanisation for terrain, implementing digital field monitoring systems, analysing yield data for decision-making, adoption of innovative practices (shade regulation sensors, automated irrigation).
3.4 Labour, Legal and Social Issues in Plantation Sector: Concepts: labour laws in plantation sector, estate labour relations, legal frameworks, plantation land rights, social compliance. Terms: plantation labour act, employee welfare, land lease, leasehold estate, minimum wage, unionisation. Processes: ensuring labour welfare, compliance with statutory regulations, managing human resources in estates (hiring, training, safety), social audits, grievance handling, sustainable estate communities.

Module IV: Strategic Management & Special Topics in Plantation Systems (10 Hours)
4.1 Diversified Plantation Systems & Agroforestry Integration: Concepts: diversification of plantation crops, combination of tree crops with other enterprises, agroforestry models in plantation landscapes. Terms: intercropping, alley cropping, shade-grown crops, multistorey cropping, silviculture in plantations. Processes: planning diversified plantations, selecting compatible crops, managing shade and competition, integrating livestock/plantation honey/eco-tourism in plantations.
4.2 Sustainable and Organic Plantation Practices: Concepts: organic plantation management, certification schemes, ecological plantation models, climate change resilience in plantations. Terms: organic certification, bio-fertiliser, bio-pesticide, carbon sequestration, agroecology. Processes: transition from conventional to organic plantation, implementing IPM and organic nutrient systems, carbon footprint assessment of plantation operations, climate smart plantation planning.
4.3 Risk Management, Plantation Rehabilitation & Replanting: Concepts: ageing plantation blocks, land degradation, risk factors (climate, pests, market), strategies for plantation rehabilitation. Terms: block rejuvenation, crop renewal, root-rot, tapping decline (rubber), shade over-mature, replacement plantation. Processes: diagnosing ageing plantation issues, planning renewal/replant cycles, cost-benefit of replacement vs maintenance, adoption of improved planting material/varieties, monitoring replanted blocks.
4.4 Emerging Trends: Biotechnology, Certification & Value Addition: Concepts: role of biotechnology in plantation crop improvement, value addition of plantation produce (processed goods), certification and traceability as market differentiators. Terms: tissue culture, improved clones, value chain enhancement, sustainability certification (Rainforest Alliance etc.), plantation tourism. Processes: selecting improved planting material, setting up value-addition units (e.g., specialty coffee, rubber goods), implementing certification standards, planning plantation tourism or experiential enterprises, branding of "estate produce".

Module 5. TEACH SPACE 15 Hrs
This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.
Theory 5Hrs
Plantation Sector in Kerala: Structure and functioning of Plantation Directorate, Government of Kerala under the Industries Department, policy framework for plantations in Kerala. overview of major estate crops in Kerala, government schemes for rejuvenation/mechanisation/worker welfare, Government estates, leasehold plantations, state regulation, value addition schemes. case studies of major government plantations, data on plantation area and registration.
Practical 10 Hrs
1. Study of plantation crops, its propagation and nursery management
2. Field visit
3. Internship for 5 days in plantation crop institutes and/or related organisations

Suggested Assignment Topics- Theory
1. Plantation crops of Kerala
2. Plantation Laws and regulations
3. Biodiversity of plantation areas
4. Problems related to plantation and its management

Suggested Assignment Topics- Practical

1. Survey on problems of plantations
2. Budgeting and Accounting of plantations
3. Internship of 5 days in Plantations of North Kerala

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Adams, M. R., & Douglass, N. (2006). *Plantation Crops: Cultivation, Management and Processing*. Agrotech Publishing Academy.
2	Balasubramanian, P., & Pillai, N. G. (2015). *Plantation Management: Principles and Practices*. New India Publishing Agency.
3	Banerjee, A. (2019). *Tea: Cultivation to Consumption*. Springer.
4	Bhat, N. R., & Thomas, K. (2017). *Management of Plantation Crops*. Scientific Publishers.
5	Bose, T. K., Kabir, J., & Maity, T. K. (2011). *Plantation Crops: Horticultural Practices*. Naya Prokash.
6	FAO. (2014). *Sustainable Management of Industrial Plantations*. Food and Agriculture Organization of the United Nations.
7	Hegde, N. G. (2012). *Agroforestry and Sustainable Land Use*. Oxford Book Company.
8	Jain, S. K., & Singh, R. (2018). *Agri-Business Management*. CBS Publishers & Distributors.
9	Kumar, A. (2020). *Principles of Plantation Crop Production*. Discovery Publishing House.
10	Mathew, J., & Kuruvilla, J. (2016). *Plantation Management in India*. Kalyani Publishers.
11	Nair, P. K. R. (1993). *An Introduction to Agroforestry*. Springer.
12	Natesan, P. (2014). *Rubber Plantation Management and Processing*. Rubber Research Institute of India.
13	Nelson, S. C., & Kurien, C. T. (2018). *Economics of Plantation Crops*. Allied Publishers.
14	Parthasarathy, V. A., & Srinivasan, V. (2006). *Spices, Plantation Crops, Medicinal and Aromatic Plants*. ICAR.
15	Pillai, K. G. (2017). *Coffee: Production, Processing and Marketing*. Oxford & IBH Publishing.
16	Purseglove, J. W. (1974). *Tropical Crops: Dicotyledons and Monocotyledons*. Longman.
17	Raj, D. (2015). *Sustainable Plantation Agriculture: Challenges and Opportunities*. Academic Foundation.
18	Ramachandran, K. M., & Mathew, K. (2021). *Agri-Business and Plantation Management*. McGraw-Hill Education.
19	Samraj, P., & George, T. (2003). *Environmental Management in Plantations*. Tea Research Association.
20	Thomas, P., & Joseph, T. (2010). *Principles of Crop Production and Plantation Management*. Pointer Publishers.

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments	➢ Lecturing

➢ Collaborative learning-Group discussion	➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**75**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal practical Examination	10

Employability for the Course / Programme
This course equips students with practical and managerial competencies essential for careers in plantation industries, agricultural enterprises, agribusiness consulting, and sustainable farm management.

51	Forest Botany	KU6DSCBOT324

DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation.
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes

CO1	Knowledge in the basic concept and principles of forest botany.
CO2	Understanding the fields of application of botanical knowledge in the field of botany
CO3	Understanding the plant adaptations in forest ecosystem with an emphasis to Western Ghats.
CO4	Interpret the adaptive and protective mechanisms exhibited by plants in response to various environmental conditions.
CO5	Ability to apply the concepts in the field of evolution and diversity studies.

<u>Mapping of Course Outcomes to PSOs/Pos</u>

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√							
CO3				√	√	√						
CO4								√	√			
CO5										√		√

Course Description

This is a comprehensive course designed for understanding the applications of botany in understanding forest ecosystems. It covers taxonomy and morphology of forest plants that equips students for sustainable forest management. The aim of the course is to give basic knowledge about the diversity of plant life forms.

- *First module gives glimpses of forestry and its relation with botany.*
- *Second module is an account on flora of Western Ghats and their adaptations.*
- *Third module emphasizes on forest trees of Western Ghats.*
- *Fourth module delves into the utilitarian aspect of forests.*

This course will also provide opportunities to observe diverse forms of plant life in forests and will help in future entrepreneurship.

Course Objectives:

1. Understand the basic principles of forestry and the classification of forest types globally and in India.
2. Examine the structural and functional diversity of plants inhabiting forest ecosystems, especially in the Western Ghats.
3. Identify and classify major forest trees based on their vegetative and morphological features.
4. Analyze the ecological significance of endemic and threatened forest species.
5. Evaluate the economic importance and sustainable utilization of forest products.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3 +0 + 2 (45 +0 +30)	5 (75)	35 (25 T and 10 P)	65 (50 T and 15 P)	100

COURSE CONTENT

Module 1. Introduction to forestry 10 Hrs

Definition, role direct and indirect benefits. General account on forest types in the World. Classification, Status and distribution of forests, with special reference to India. Comparative primary productivity of different types of forest ecosystems in the world. Basic concepts on Forest types of India and Kerala Champion & Seth Revised system of classification

Module 2. Diversity of plants in forests in Western Ghats 10 Hrs

Types of plant forms in tropical rain forests-Trees, Herbs, Shrubs, Creepers, Lianas, Twiners, Epiphytes. Annuals, Biennials, Perennials. Major plant groups- bryophytes, Pteridophytes, gymnosperms and angiosperms. Adaptation in forest environment- Structure of leaves, stem wood , bark and roots in trees, Adaptations with special reference to shade tolerance, leaf modifications, Root systems, seed dispersal mechanism, epiphytic adaptations and mycorrhiza associations

Types of woody plants. Comparative wood anatomy of gymnosperms and angiosperms. Soft wood and hardwood. Dendrochronology and Dendroclimatology.

Module 3. Major forest trees of Western Ghats 10 Hrs

Concept of Endemic and RET plants. Significance, Threats and consequences of loss. Red data book, An overview of major RET and Endemic trees of Western Ghats. Role of vegetative characters in identification of forest trees- the bole, buttresses, flute, leaf characters, colour of younger and older leaves, characteristic of bark, blaze and exudations. Tree identification and classification based on morphology of stem and leaves and architecture. Tree forms, shapes and architecture. Importance scope of dendrology

Module 4. Useful Forest products and plants 10 Hrs

Major Timbers, Non timber forest products- bamboo and canes, resins, tannins, honey, Forest products and their utilization in industries and entrepreneurships. An overview of Gadgil Committee Report, Oommen V Ommen report.

Module 5. TEACH SPACE 9 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

THEORY 9 Hrs

Natural and anthoropogenic factors affecting forests. Gadgil committee report Vs Kasthurirangan report.

Practicals 30 hrs

1. Collection and documentations of forest products.
2. Tree architecture types
3. RET plants of western ghats
4. Endangered fauna of Westernghats
5. Visit to forest area and document the diversity.
6. Collect news and photographs regarding the forest.

7. Nature camp for 3 days 8. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Vegetation types of India
2. Types of products and their documentation

Suggested Assignment Topics- Practical

1. Microphotographs of all practical works
2. Collection documentation and classification of diverse forms of plant life in forestry.

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bor, N. L. (1953). Manual of Indian forest botany. Manual of Indian forest botany.
2	Burton, L D, 2019. Introduction To Forestry Science, Cengage India.
3	Champion, H. G. (1936). *A Preliminary Survey of the Forest Types of India and Burma.* Oxford University Press.
4	Champion, H. G., & Seth, S. K. (1968). *A Revised Survey of the Forest Types of India.* Government of India Press.
5	Esau, K. (2002). *Anatomy of Seed Plants* (2nd ed.). Wiley.
6	Fahn, A. (1990). *Plant Anatomy.* Pergamon Press.
7	FAO. (2010). *Global Forest Resources Assessment 2010.* Food and Agriculture Organization of the United Nations.
8	FAO. (2015). *Global Forest Resources Assessment*. Rome: FAO of United Nations.
9	Grebner D.L., 2024. Introduction To Forestry and Natural Resources, Elsevier.
10	Kaul, R. N. (2012). *Forestry in India.* International Book Distributors.
11	Kochhar, S. L. (2017). *Economic Botany: A Comprehensive Study.* Cambridge University Press India.
12	Krishnamurthy, K. V. (2015). *An Advanced Textbook on Biodiversity: Principles and Practice.* Oxford & IBH.
13	Mukherjee, P, 2016. Flora of the Southern Western Ghats and Palnis, Niyogi books.
14	Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. B., & Kent, J. (2000). *Biodiversity Hotspots for Conservation Priorities. Nature*, 403(6772), 853–858.
15	Nayar, M. P. (1996). *Hotspots of Endemic Plants of India, Nepal and Bhutan.* Tropical Botanic Garden and Research Institute.
16	Negi S S, 2012. Forest Botany, Bishen Singh Mahendrapal Singh
17	Pandey, B. P. (2015). *A Textbook of Botany: Angiosperms.* S. Chand Publishing.
18	Parthasarathy, N., & Karthikeyan, R. (2018). *Ecology and Conservation of Tropical Forest Plants in India.* Springer Nature.
19	Pascal, J. P. (1988). *Wet Evergreen Forests of the Western Ghats of India: Ecology, Structure, Floristic Composition and Succession.* Institut Français de Pondichéry.
20	Pullaiah, T., 2024. Biodiversity Hot Spots of the Western Ghats and Srilanka, CRC Press.
21	Puri, G. S., Meher-Homji, V. M., Gupta, R. K., & Puri, S. (1989). *Forest Ecology (Vols. 1–4).* Oxford & IBH.

22	Raj, A J., 2013. Forestry Principles And Applications, Scientific Publishers
23	Richards, P. W. (1996). *The Tropical Rain Forest: An Ecological Study* (2nd ed.). Cambridge University Press.
24	Roth, I. (1981). *Structural Patterns of Tropical Barks.* Springer-Verlag.
25	Sarmah D, 2024. Distribution of trees across the Western Ghats in Karnataka, Notion Press.
26	Shanmughavel P, 2014. Forest Botany, Pointer Publishers
27	Singh, J. S., & Kushwaha, C. P. (2010). *Forest Ecosystem: Structure and Function.* Springer.
28	Sivanna, H, 2012. Handbook on Forest Biology, Discovery Publishing House
29	Sterck, F., & Turnbull, C. (2005). Woody tree architecture. Annual Plant Reviews, Plant Architecture and its Manipulation, 17, 210-237.
30	Tewari, D. N. (1994). *A Monograph on Bamboo.* International Book Distributors.
31	Tomlinson, P. B. (1990). *The Structural Biology of Palms.* Oxford University Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination-Theory	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	15
• Writing assignment/ Seminar presentation	10
• Practical Examination + Laboratory reports	10

Employability for the Course / Programme

It is one of the advanced courses which is very helpful in understanding the diversity of plant life

52	Ethnobotany		KU6DSCBOT325
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation.
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Explain the evolution, scope, and importance of ethnobotany and traditional knowledge systems.
CO2	Conduct ethnobotanical field studies using appropriate methodologies and ethical guidelines.
CO3	Analyze the cultural, medicinal, and ecological roles of plants in different societies.
CO4	Evaluate conservation strategies and policy mechanisms related to biodiversity and traditional knowledge protection.
CO5	Apply modern technologies and interdisciplinary approaches to document, preserve, and promote ethnobotanical knowledge for sustainable development.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course explores the intricate relationship between plants and human societies, emphasizing indigenous knowledge, cultural plant use, conservation ethics, and the integration of traditional wisdom with modern scientific and policy frameworks.

- *First module introduces the foundations of ethnobotany, tracing its evolution, scope, and interrelation with anthropology and ecology, while highlighting the significance of traditional knowledge in cultural heritage and sustainable resource management.*
- *Second module focuses on research methodologies, traditional health systems, and the cultural, spiritual, and economic dimensions of plant use, emphasizing community participation and ethical documentation.*
- *Third module examines the role of ethnobotany in biodiversity conservation and policy development, highlighting community-based resource management, legal frameworks, and international conventions protecting traditional knowledge.*
- *Fourth module explores modern tools, ethical considerations, and emerging applications of ethnobotany in sustainable development, biocultural conservation, and innovative interdisciplinary research.*

This course will provide opportunities to excel in ethnobotanical studies, research and entrepreneurships.

Course Objectives:

1. To provide a foundational understanding of ethnobotany, its historical development, and interdisciplinary relevance.
2. To develop knowledge of field methods, data collection, and analytical approaches in ethnobotanical research.
3. To examine the cultural, medicinal, and economic significance of plants in traditional societies.
4. To understand legal, ethical, and policy frameworks governing the use and protection of traditional knowledge.
5. To explore contemporary tools, technologies, and applications that integrate ethnobotanical knowledge into sustainability and conservation efforts.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 1 (45+ 0 + 30)	5	35	65	100

COURSE CONTENT

MODULE I: Introduction to Ethnobotany and Traditional Knowledge Systems *(9 Hours)*

1.1 Definition, Scope and Historical Development of Ethnobotany: Origin and development of ethnobotany as a discipline; relation to anthropology, botany, and ecology. Ethnobotany, ethnopharmacology, economic botany, traditional ecological knowledge (TEK). Historical milestones – from ancient herbals to modern ethnobotanical research; methodology of linking plants to culture and human utility.

1.2 Branches and Applications of Ethnobotany: Subfields – ethnomedicine, ethnopharmacology, ethnoecology, ethno-agriculture, and ethnoveterinary science. Cultural botany, indigenous technology, folk medicine, food ethnobotany. Documentation of traditional plant uses, participatory research with local communities, integration of ethnobotanical knowledge in biodiversity conservation.

1.3 Role of Indigenous Knowledge in Sustainable Development: Traditional resource management and ecological balance; role of indigenous practices in sustainable living. Traditional knowledge (TK), customary rights, benefit-sharing, bioprospecting. Integration of traditional practices into modern conservation and agroforestry systems; recognizing traditional plant-based resource management in policy.

1.4 Documentation and Preservation of Traditional Knowledge: Importance of documenting indigenous knowledge before it is lost; ethics in documentation. TKDL (Traditional Knowledge Digital Library), oral traditions, participatory rural appraisal (PRA), informed consent. Methods of data collection — interviews, ethnographic mapping, participatory observation, digital archiving, use of GIS and databases.

MODULE II: Ethnobotanical Studies and Cultural Plant Relationships *(9 Hours)*

2.1 Methods and Approaches in Ethnobotanical Research: Methodologies for field data collection, quantitative ethnobotany, community-based research ethics. Ethnobotanical inventory, use-value index, informant consensus factor (ICF), cultural significance index. Designing ethnobotanical field studies, selecting informants, developing questionnaires, data analysis and interpretation.

2.2 Plants in Traditional Health Systems: Plant-based healing practices in Ayurveda, Siddha, Unani, and tribal medicine. Materia medica, ethnomedicine, ritual healing, sacred groves, ethnopharmacology. Collection and authentication of medicinal plants, identification of active ingredients, preparation of traditional formulations, validation of therapeutic claims.

2.3 Plants in Food, Culture and Rituals: Role of plants in food habits, religious ceremonies, and cultural identity. Sacred plants, ritualistic plants, food ethnobotany, cultural keystone species. Documentation of food traditions, use of plants in festivals, marriage rituals, and religious offerings; study of plant symbolism in folklore.

2.4 Economic and Social Aspects of Ethnobotany: Commercial and livelihood aspects of ethnobotanical practices. Non-timber forest products (NTFPs), minor forest produce, traditional crafts, eco-enterprises. Value addition of traditional plant products, community entrepreneurship, sustainable marketing of herbal and forest produce.

MODULE III: Ethnobotany, Conservation and Policy Frameworks (9Hours)

4.1 Ethnobotany in Biodiversity Conservation: Role of traditional and indigenous knowledge in plant conservation and ecosystem management. In situ and ex situ conservation strategies — sacred groves, community reserves, ethnobotanical gardens, seed banks. Concept of biocultural diversity and its importance in sustaining cultural and ecological heritage. Case studies on community-based conservation models and traditional conservation practices in India and globally.

4.2 Community-Based Conservation and Sustainable Resource Management: Traditional ecological knowledge (TEK) in sustainable harvesting and habitat protection. Community forest management, joint forest management (JFM), and participatory rural approaches. Integration of ethnobotanical knowledge into modern agroforestry, biodiversity conservation, and ecosystem restoration. Role of local communities, NGOs, and governmental agencies in implementing conservation programs.

4.3 Legal and Policy Frameworks in Ethnobotany: Overview of national and international biodiversity laws and conventions: Convention on Biological Diversity (CBD). Nagoya Protocol on Access and Benefit Sharing (ABS). World Intellectual Property Organization (WIPO). Biological Diversity Act (2002, India) and associated rules. Intellectual Property Rights (IPR), patents, and protection of traditional knowledge. Mechanisms for preventing biopiracy and ensuring equitable benefit-sharing. Institutional frameworks supporting ethnobotanical research and traditional knowledge documentation (e.g., TKDL, NBA, UNESCO initiatives).

4.4 Policy Integration and Future Directions: Incorporating ethnobotanical knowledge into national biodiversity strategies and climate action plans. Policy measures promoting sustainable livelihoods, eco-enterprises, and cultural heritage conservation. Ethical considerations in documentation and commercialization of traditional knowledge. Emerging trends: community-led policies, biocultural protocols, and global recognition of indigenous stewardship in conservation.

Module 4: Contemporary Trends, Ethics, and Future Directions in Ethnobotany (9Hours)

4.1 Modern Tools and Technologies in Ethnobotanical Research: Use of GIS, remote sensing, and digital databases in ethnobotany. Molecular ethnobotany and phytochemical screening of medicinal plants. Bioinformatics and AI in traditional knowledge management. Digitization and data sharing: opportunities and challenges.

4.2 Community Participation and Applied Ethnobotany: Participatory rural appraisal (PRA) and community-based conservation. Linking local knowledge with education, ecotourism, and sustainable development. Role of NGOs, research institutions, and policy makers in promoting ethnobotanical awareness.

4.3 Ethics, Equity, and Benefit Sharing: Ethical guidelines for research with indigenous communities. Free Prior Informed Consent (FPIC) and equitable benefit-sharing mechanisms. Cultural sensitivity and respect for indigenous intellectual traditions. Challenges of commercialization and cultural appropriation.

4.4 Future Prospects of Ethnobotany: Emerging trends: Ethnopharmacological innovation, ethnocosmetics, nutraceuticals. Integration of traditional knowledge with modern science. Ethnobotany in climate change adaptation and global sustainability agendas. Career opportunities and interdisciplinary collaborations in ethnobotanical research.

Module 5. TEACH SPACE 9 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5Hrs

Ethno medicine Successful stories from India and Abroad.

Practical 30 Hrs

1. Study of different tribal groups 2. Survey on ethnomedicines 3. Major ethnoplants of our locality and their documentation 4. Phytochemical studies 5. Antimicrobial anti viral property studies

Suggested Assignment Topics- Theory

1. Molecular Docking
2. Drug Discovery

Suggested Assignment Topics- Practical

1. Phytochemistry of ethno plants
2. Reference collection on medicinal plants

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Albuquerque, U. P., & Hanazaki, N. (2009). *Recent Developments and Case Studies in Ethnobotany.* Springer.
2	Balick, M. J., & Cox, P. A. (2020). *Plants, People, and Culture: The Science of Ethnobotany* (2nd ed.). CRC Press.
3	Berlin, B. (1992). *Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies.* Princeton University Press.
4	Cotton, C. M. (1996). *Ethnobotany: Principles and Applications.* John Wiley & Sons.
5	Cox, P. A. (2000). *Will Tribal Knowledge Survive the Millennium?* Science, 287(5450), 44–45.
6	Cox, P. A., & Balick, M. J. (1994). *The Ethnobotanical Approach to Drug Discovery.* Scientific American.
7	Cunningham, A. B. (2001). *Applied Ethnobotany: People, Wild Plant Use and Conservation.* Earthscan.
8	Gadgil, M., Berkes, F., & Folke, C. (1993). *Indigenous Knowledge for Biodiversity Conservation.* Ambio, 22(2–3), 151–156.
9	Hamilton, A. C. (2004). *Medicinal Plants, Conservation and Livelihoods.* Biodiversity & Conservation, 13(8), 1477–1517.
10	Heinrich, M., & Jäger, A. K. (2015). *Ethnopharmacology.* Wiley-Blackwell.
11	Jain, S. K. (2010). *Manual of Ethnobotany* (2nd ed.). Scientific Publishers.
12	Jain, S. K. (Ed.). (1981). *Glimpses of Indian Ethnobotany.* Oxford & IBH Publishing.
13	Jain, S. K., & Mudgal, V. (1999). *A Handbook of Ethnobotany.* Bishen Singh Mahendra Pal Singh.
14	Kiple, K. F., & Ornelas, K. C. (Eds.). (2000). *The Cambridge World History of Food.* Cambridge University Press.
15	Maffi, L. (2005). *Linguistic, Cultural, and Biological Diversity.* Annual Review of Anthropology, 34, 599–617.
16	Martin, G. J. (2004). *Ethnobotany: A Methods Manual.* Earthscan Publications.
17	Pei, S. J., & Xu, J. C. (1995). *Ethnobotany and Sustainable Development.* Yunnan Science and Technology Press.
18	Pei, S., & Huai, H. (2007). *Ethnobotany and Modernization of Traditional Knowledge in China.* Journal of Ethnobiology and Ethnomedicine, 3(3).
19	Phillips, O., & Gentry, A. H. (1993). *The Useful Plants of Tambopata, Peru: Statistical Hypotheses Tests with a New Quantitative Technique.* Annals of the Missouri Botanical Garden.
20	Posey, D. A. (1999). *Cultural and Spiritual Values of Biodiversity.* UNEP.

21	Rajasekharan, P. E., & Job, C. (Eds.). (2016). *Ethnobotany and Conservation of Biocultural Diversity.* Indian Council of Agricultural Research.
22	Schultes, R. E., & von Reis, S. (1995). *Ethnobotany: Evolution of a Discipline.* Timber Press.
23	Singh, K. K., & Kumar, K. (2000). *Ethnobotany of Bihar.* Scientific Publishers.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal practical examination	15

Employability for the Course / Programme

This course equips students with the interdisciplinary skills needed for careers in biodiversity conservation, ethnopharmacology, herbal and nutraceutical industries, environmental consultancy, cultural heritage documentation, and policy research. Bottom of Form

53	Herbal Science		KU6DSCBOT326
DSC	**Semester: 6**	**Hrs/week: 3 Theory+ 1 practical**	**Credits: 4**

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation.
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Demonstrate conceptual clarity on the traditional and scientific foundations of herbal science and ethnobotany.
CO2	Identify, classify, and document medicinal plants using pharmacognostic and ethnobotanical techniques.
CO3	Apply knowledge of phytochemical extraction, standardization, and formulation in developing herbal products.
CO4	Implement cultivation, processing, and value addition practices in the herbal and aromatic plant sector.
CO5	Critically analyze emerging technologies, research advances, and policies governing global herbal medicine.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√										
CO2						√						
CO3							√	√		√		
CO4								√		√	√	
CO5									√	√	√	√

Course Description

This course explores the ancient and modern dimensions of plant-based medicine, combining traditional wisdom with scientific validation.

- *The foundational module introduces herbal science and ethnobotany as interdisciplinary fields linking traditional plant knowledge with modern science.*
- *Second module delves into the chemical basis of herbal medicine by studying primary and secondary metabolites, their extraction, and their pharmacological significance.*
- *Third module provides practical insights into the cultivation, harvesting, and processing of medicinal and aromatic plants.*
- *The final module integrates traditional medicine systems with modern scientific advances.*

The course integrates biotechnology, safety standards, and policy frameworks to prepare learners for research, entrepreneurship, and industrial applications in the growing herbal sector.

Course Objectives:

1. Explain the concept, scope, and relevance of herbal science and ethnobotany in modern healthcare.
2. Understand the classification, phytochemistry, and pharmacological properties of medicinal plants.
3. Acquire knowledge of cultivation, processing, and marketing of herbal and aromatic plants.

4. Evaluate the quality, safety, and regulatory aspects of herbal formulations.
5. Analyze the role of biotechnology, global trade, and intellectual property rights in herbal industries.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 1 (45+ 0 + 30)	3	35	65	100

COURSE CONTENT

MODULE I: Introduction to Herbal Science and Ethnobotany *(9 Hours)*

1.1 Concept and Scope of Herbal Science: Concepts: Definition, scope, and importance of herbal science; distinction between herbal and synthetic medicines; history of herbal use in human civilization. Terms: Medicinal plants, phytotherapy, ethnobotany, pharmacognosy, Ayurveda, Unani, Siddha, Traditional Chinese Medicine (TCM)..

1.2 Classification and Nomenclature of Medicinal Plants: Basis for classification — morphological, phytochemical, and therapeutic properties. Botanicals, crude drugs, pharmacopoeia, monographs, chemotaxonomy. Scientific naming of medicinal plants; preparation of herbarium and field identification keys; use of pharmacopoeial references for identification.

1.3 Ethnobotanical Knowledge and Indigenous Systems: Indigenous traditional knowledge systems in India; role of tribal and rural communities in medicinal plant conservation. Ethnobotany, ethnomedicine, traditional healers (Vaidyas), folklore medicine. Ethnobotanical surveys, documentation methods (questionnaires, participatory rural appraisal), intellectual property rights and benefit sharing (TKDL, WIPO).

1.4 Conservation and Sustainable Utilization of Medicinal Plants**: T**hreats to medicinal plants, conservation strategies (in situ and ex situ). Germplasm conservation, biosphere reserves, gene banks, cultivation practices. Establishment of medicinal plant gardens, sustainable harvesting methods, conservation through community-based resource management.

MODULE II: Phytochemistry and Active Principles of Medicinal Plants *(9 Hours)*

2.1 Primary and Secondary Metabolites: Classification of plant metabolites; role of secondary metabolites in plant defense and therapeutic uses. Alkaloids, flavonoids, tannins, glycosides, terpenoids, saponins, phenolics. methods for extraction and isolation of phytochemicals.

2.2 Extraction, Processing, and Standardization: Techniques for extraction and purification of herbal constituents; importance of quality assurance and standardization. Solvent extraction, Soxhlet extraction, chromatography (TLC, HPLC, GC-MS). Stepwise extraction and fractionation; drying, powdering, and preservation of raw herbal materials; quality control standards (WHO guidelines, AYUSH protocols).

2.3 Pharmacological and Therapeutic Actions of Plant Constituents: Relationship between phytochemicals and their biological activity; pharmacological classification of plant-derived drugs. Antimicrobial, anti-inflammatory, antioxidant, hepatoprotective, anticancer, adaptogen. Screening for bioactivity (in vitro and in vivo); mechanisms of action of key phytoconstituents.

2.4 Toxicity, Safety and Quality Control in Herbal Medicines: Importance of quality control and safety evaluation; toxic effects of herbal drugs and adulteration issues. Adulterants, contaminants, pharmacovigilance, dosage forms, therapeutic index. Standardization of herbal formulations; safety assessment protocols (LD50 studies); regulatory frameworks (WHO, AYUSH, FSSAI, ISO standards).

MODULE III: Cultivation and Processing of Medicinal and Aromatic Plants *(9 Hours)*

3.1 Principles of Cultivation of Medicinal Plants: Agro-climatic requirements, soil and water management, crop planning for medicinal species. Propagation, nursery management, organic farming, interculture operations. Selection of planting material; propagation by seeds, cuttings, tissue culture; spacing, irrigation, and weed control.

3.2 Post-Harvest Management and Storage: Importance of proper post-harvest handling to maintain phytochemical integrity. Drying (shade, tray, solar);, curing, grading, packaging, shelf-life, moisture content. grading and packaging standards; prevention of microbial spoilage during storage.
3.3 Processing and Value Addition: Methods for preparing herbal products — powders, extracts, oils, syrups, ointments. Decoction, infusion, tincture, essential oils, distillation, standard formulations. Manufacturing flow for herbal formulations; quality assurance in herbal industries; GMP (Good Manufacturing Practices).
3.4 Marketing and Entrepreneurship in Herbal Industry: Herbal product marketing strategies, branding, certification, and export potential. Branding, labeling, certification (organic, eco-labels), nutraceuticals, cosmeceuticals. Developing business models for herbal products; regulatory compliance for export; market analysis and value chain in herbal trade.

MODULE IV: Therapeutic Applications and Modern Developments in Herbal Science *(9 Hours)*

4.1 Major Systems of Herbal Medicine: Comparative study of Ayurveda, Siddha, Unani, and Traditional Chinese Medicine. Rasayana, Dravyaguna, formulation, materia medica, pharmacopeia. Preparation of traditional formulations; understanding Tridosha concept and plant categorization by Rasa, Guna, and Veerya.
4.2 Modern Research and Biotechnology in Herbal Science: Application of biotechnology and molecular tools in herbal research. Tissue culture, metabolite enhancement, molecular markers, barcoding. Micropropagation of medicinal plants; metabolic engineering; DNA barcoding for authentication.
4.3 Herbal Formulations and Phytopharmaceuticals: Development of polyherbal formulations and standardized herbal drugs. Polyherbal combinations, phytopharmaceuticals, nano-herbal formulations. Formulation design, standardization, preclinical and clinical evaluation of herbal products.
4.4 Global Trends, Policies, and Intellectual Property Rights (IPR): Global herbal market trends; policies governing herbal medicine trade; protection of traditional knowledge. IPR, patents, TKDL (Traditional Knowledge Digital Library), WIPO. Patent filing processes; case studies of successful herbal drugs; policy frameworks for bioprospecting and benefit-sharing.

Module 5. TEACH SPACE 9 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 9Hrs

Overview of Kerala's rich biodiversity and traditional knowledge base in herbal medicine. Medicinal trees: *Saraca asoca*, *Azadirachta indica*, *Terminalia chebula*, *Phyllanthus emblica*. Herbs and shrubs: *Ocimum tenuiflorum* (Tulsi), *Curcuma longa* (Turmeric), *Aloe vera*, *Zingiber officinale* (Ginger).Climbers and others: *Tinospora cordifolia*, *Withania somnifera*, *Centella asiatica*.
Conservation and cultivation practices promoted by the Kerala State Medicinal Plants Board (KSMPB); ethnobotanical garden establishment; integration of herbal plants into agroforestry.

Practical 30 Hrs

1. Study of medicinal plants and their phytochemistry
2. Survey on medicinal plants and their folkuses
3. Internship for 2days in a traditional healers camp
4. Internship for 3 days in a medicine manufacturing company
5. Adivasi settlement visit
6. Documentation of herbal medicines used in daily life

Suggested Assignment Topics- Theory

1. Adulteration in medicinal plants – classical examples
2. Problems related to single remedies and folk medicines
3. Role of Medcinial plant Boards
4. Phytochemistry of medicinal plants

Suggested Assignment Topics- Practical

1. Survey of folk medicines and their use
2. Visiting medicine manufacturing companies- Kalarippayattu/Ayurveda / Siddha/ Unani
3. Compilation of ethnomedicine formulations

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Alonso, J. R. (2019). *Phytotherapy: Principles and Practice of Herbal Medicine*. CRC Press.
2	Balick, M. J., & Cox, P. A. (2020). *Plants, People, and Culture: The Science of Ethnobotany* (2nd ed.). CRC Press.
3	Chatwal, G. R., & Anand, S. K. (2010). *Instrumental Methods of Chemical Analysis*. Himalaya Publishing House.
4	Evans, W. C. (2009). *Trease and Evans' Pharmacognosy* (16th ed.). Saunders Elsevier.
5	Harborne, J. B. (1998). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis* (3rd ed.). Springer.
6	Heinrich, M., & Barnes, J. (2015). *Fundamentals of Pharmacognosy and Phytotherapy* (2nd ed.). Churchill Livingstone.
7	Jain, S. K. (2010). *Manual of Ethnobotany* (3rd ed.). Scientific Publishers.
8	Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2017). *Pharmacognosy* (50th ed.). Nirali Prakashan.
9	Mukherjee, P. K. (2015). *Evidence-Based Validation of Herbal Medicine*. Elsevier.
10	Mukherjee, P. K. (2019). *Quality Control and Evaluation of Herbal Drugs* (2nd ed.). Elsevier.
11	Pandey, B. P. (2016). *Economic Botany*. S. Chand Publishing.
12	Rasool, H. (2018). *Textbook of Pharmacognosy and Phytochemistry*. CBS Publishers.
13	Satyavati, G. V., Raina, M. K., & Sharma, M. (1987). *Medicinal Plants of India* (Vols. I–II). Indian Council of Medical Research.
14	Singh, J., & Khar, R. K. (2012). *Pharmacognosy and Phytochemistry*. CBS Publishers.
15	Sofowora, A. (2008). *Medicinal Plants and Traditional Medicine in Africa* (3rd ed.). Spectrum Books.
16	Srivastava, R. C. (2015). *Traditional Knowledge and Biodiversity Conservation*. TERI Press.
17	Tyler, V. E., Brady, L. R., & Robbers, J. E. (1988). *Pharmacognosy*. Lea & Febiger.
18	WIPO. (2020). *Intellectual Property and Genetic Resources, Traditional Knowledge and Traditional Cultural Expressions*. World Intellectual Property Organization.
19	World Health Organization. (2013). *WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants*. WHO Press.
20	Wyk, B. E. van. (2015). *Medicinal Plants of the World: An Illustrated Scientific Guide*. Timber Press.

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits and surveys ➢ Documentation of formulations	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Internal Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	5
• Internal Practical examination	15

Employability for the Course / Programme

Graduates may find roles as research associates, pharmacognosists, herbal product developers, quality assurance officers, biodiversity consultants, or entrepreneurs in the herbal trade.

54	Modern Plant Pathology		KU6DSCBOT327
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation.
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Explain the nature, classification, and life cycles of plant pathogens.
CO2	Analyze host–pathogen interactions at cellular and molecular levels.
CO3	Employ modern diagnostic and molecular tools for pathogen identification.
CO4	Develop integrated and sustainable plant disease management strategies.
CO5	Apply advanced concepts in biotechnology, nanotechnology, and climate-based disease forecasting in plant pathology.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course introduces students to modern concepts in plant pathology, including host–pathogen interactions, plant immune systems, pathogen genomics, and eco-friendly disease management strategies.

- *First module is dealing with the conceptual framework of plant pathology, exploring the types, causes, and classification of plant diseases.*
- *Second module focusses on the physiological and molecular dialogue between hosts and pathogens.*
- *Third module focuses on advanced tools and technological innovations in plant pathology, emphasizing rapid diagnostics, disease forecasting, and data-driven epidemiology.*
- *Final module integrates classical and modern strategies for disease control.*

Emphasis is placed on diagnostic tools, molecular techniques, and sustainable plant health management, preparing learners for future roles in agriculture, biotechnology, and environmental science.

Course Objectives:

1. To understand the causes, mechanisms, and consequences of plant diseases.
2. To learn about the physiology, biochemistry, and genetics of host–pathogen interactions.
3. To explore modern diagnostic and molecular tools in plant disease detection and forecasting.

4. To evaluate eco-friendly and integrated approaches to disease management.
5. To prepare students for applied research, biotechnology applications, and agricultural disease control programs.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 1 (45+ 0 + 30)	3	25	50	75

COURSE CONTENT

MODULE I: Fundamentals of Plant Pathology (10 Hours)

Definition, history, and scope of plant pathology. Types of plant diseases – infectious vs non-infectious. Classification of plant pathogens – fungi, bacteria, viruses, phytoplasmas, nematodes. Koch's postulates and pathogenicity concepts. Disease triangle: host–pathogen–environment interactions. Pathogen life cycles and disease development stages (infection, colonization, symptom expression).

MODULE II: Host–Pathogen Interaction and Molecular Basis of Disease (10 Hours)

Host specificity and compatibility. Mechanisms of infection and colonization (enzymes, toxins, effectors). Molecular signaling in pathogenesis (elicitors, PAMPs, effectors). Plant defense mechanisms – structural and biochemical barriers. Plant immune responses: PTI (Pattern-Triggered Immunity), ETI (Effector-Triggered Immunity). Hypersensitive response, systemic acquired resistance (SAR), induced systemic resistance (ISR). Genetic basis of resistance – gene-for-gene hypothesis, R and Avr genes.

MODULE III: Modern Diagnostic and Epidemiological Tools (12 Hours)

Disease diagnosis: symptomatology, microscopy, isolation, culturing. Serological and molecular methods: ELISA, PCR, qPCR, RT-PCR, LAMP. DNA barcoding and sequencing of pathogens. Bioinformatics and omics in pathogen identification (genomics, transcriptomics, proteomics). Disease epidemiology: temporal and spatial disease dynamics. Disease forecasting models and remote sensing in disease surveillance. Artificial intelligence and machine learning in disease prediction.

MODULE IV: Disease Management and Sustainable Practices (13 Hours)

Principles of plant disease management. Cultural, mechanical, biological, chemical, and legislative control measures. Fungicides and biopesticides – mode of action and resistance management. Biological control agents: *Trichoderma*, *Bacillus*, *Pseudomonas*. Molecular breeding for disease resistance (MAS, RNAi, CRISPR). Plant disease forecasting and decision support systems. Climate change and emerging plant diseases. Nanotechnology and biosensors in disease detection and management.

Module 5. TEACH SPACE 15 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5Hrs

Major plant diseases for the crops in Kerala.

Practical 30 Hrs

1. Study of common symptoms of fungal, bacterial, and viral diseases.
2. Isolation, culturing, and identification of fungal pathogens (*Alternaria*, *Fusarium*, *Rhizoctonia*).
3. Microscopic examination of conidia, mycelia, and fruiting bodies.

4. Staining and identification of bacterial plant pathogens.
5. Preparation of Koch's postulates for a common disease (e.g., leaf spot).
6. Estimation of disease incidence and severity; calculation of disease index.
7. Serological methods: demonstration of ELISA for viral detection.
8. DNA extraction from infected leaves and PCR demonstration for pathogen detection.
9. Study of hypersensitive response in tobacco plants.
10. Demonstration of biocontrol efficacy of *Trichoderma* or *Pseudomonas*.
11. Visit to a plant pathology research institute or agricultural disease diagnostic lab.

Suggested Assignment Topics- Theory

1. International developments and collaborations for IPM and IDM
2. Seed certification
3. Quarantine measures

Suggested Assignment Topics- Practical

1. Innovative Pesticide formulations
2. New control measures for various pathogens

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Agrios, G. N. (2005). *Plant Pathology* (5th ed.). Elsevier Academic Press.
2	Lucas, J. A. (2020). *Plant Pathology and Plant Pathogens* (4th ed.). Wiley-Blackwell.
3	Strange, R. N. (2003). *Introduction to Plant Pathology.* Wiley.
4	Mehrotra, R. S., & Aggarwal, A. (2017). *Plant Pathology* (3rd ed.). Tata McGraw Hill.
5	Schumann, G. L., & D'Arcy, C. J. (2010). *Essential Plant Pathology* (2nd ed.). APS Press.
6	Singh, R. S. (2009). *Introduction to Principles of Plant Pathology.* Oxford & IBH.
7	Dickinson, M. (2015). *Molecular Plant Pathology.* BIOS Scientific Publishers.
8	Gupta, S. K., & Singh, D. V. (2014). *Plant Diseases: Epidemiology and Management.* Scientific Publishers.
9	Mandahar, C. L. (2006). *Introduction to Plant Viruses.* Allied Publishers.
10	Tuite, J. (2016). *Plant Pathological Methods: Fungi and Bacteria.* Agrobios.
11	Bos, L. (2000). *The Plant Viruses: Molecular Biology and Control.* Plenum Press.
12	Sumbali, G. (2018). *The Science of Plant Pathology.* CRC Press.
13	Dickinson, M. (2003). *Molecular Tools for Screening Biodiversity.* Chapman & Hall.
14	Gupta, S. K., & Pandey, R. N. (2019). *Plant Pathology: Fundamentals and Techniques.* CBS Publishers.
15	Walters, D. R. (2009). *Disease Control in Crops: Biological and Environmentally Friendly Approaches.* Wiley.
16	Reddy, M. N. (2012). *Advances in Plant Pathology.* Scientific Publishers.
17	Collinge, D. B., et al. (2002). *Plant Pathogen Resistance Biotechnology.* Wiley-Blackwell.
18	Thind, T. S. (2015). *Fungicides in Plant Disease Management.* Scientific Publishers.
19	Pereira, M. S., & Camargo, M. E. (2021). *Plant Disease Forecasting and Management.* Springer.
20	Chowdappa, P., & Nirmala, M. (2017). *Integrated Plant Disease Management in Tropical Agriculture.* Today & Tomorrow's Printers and Publishers.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Collaborative learning-Group discussion ➢ Lab experiments ➢ Field visit	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Practical Examination	10

Employability for the Course / Programme

This course equips students for diverse career opportunities in agricultural biotechnology, crop protection industries, seed health testing, research institutions, quarantine services, and environmental consulting.

55	Horticulture		KU6DSCBOT328
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation.
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Identify and classify major horticultural crops and their modern cultivation techniques.
CO2	Apply innovative propagation and nursery management practices.
CO3	Utilize modern tools for protected cultivation, hydroponics, and precision horticulture.
CO4	Implement post-harvest handling, storage, and value addition strategies.
CO5	Develop entrepreneurial skills for horticulture-based businesses and research projects.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

Horticulture is the science, art, and business of cultivating fruits, vegetables, flowers, ornamental plants, and medicinal and aromatic plants.

- *First module provides an overview of horticulture—its scope, classification, and significance—while exploring crop diversification across different climatic zones and its contribution to nutrition, sustainability, and global agricultural trends.*
- *Second module introduces the principles and practices of plant propagation, nursery management, and advanced cultivation methods, emphasizing modern technologies like hydroponics, precision horticulture, and smart farming systems.*
- *Third module focuses on understanding plant nutritional needs, maintaining soil health, and implementing integrated and sustainable pest, disease, and stress management strategies for optimized crop productivity.*
- *Fourth module explores controlled-environment farming systems, post-harvest handling techniques, and value addition processes, highlighting innovation, sustainability, and entrepreneurship in modern horticulture..*

This course exposes students to both classical horticultural practices and innovative technologies to prepare them for careers in agriculture, agribusiness, and research.

Course Objectives:

1. To understand the fundamentals of horticulture including fruit, vegetable, ornamental, medicinal, and aromatic plants.
2. To explore modern technologies such as protected cultivation, hydroponics, tissue culture, and precision farming.
3. To study propagation techniques, plant nutrition, and integrated pest and disease management.
4. To learn post-harvest management, value addition, and entrepreneurship opportunities in horticulture.
5. To prepare students for research, industry, and agribusiness careers in modern horticulture.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 1 (45+ 0 + 30)	3	25	50	75

COURSE CONTENT

MODULE I: Introduction to Horticulture and Crop Diversification (10 Hours)

Definition, scope, and importance of horticulture. Classification: fruits, vegetables, ornamental, medicinal, and aromatic plants. Diversification in horticulture: temperate, subtropical, and tropical crops. Trends in global and Indian horticulture. Role of horticulture in nutrition, environment, and sustainable development.

MODULE II: Propagation, Nursery Management, and Modern Cultivation Techniques (12 Hours)

Sexual and asexual propagation: seeds, cuttings, grafting, budding, layering, micropropagation. Nursery planning and management. Modern cultivation techniques: raised beds, mulching, fertigation, pruning, and training. Hydroponics, aeroponics, and aquaponics. Precision horticulture: drip irrigation, sensors, remote sensing, and IoT in crop management.

MODULE III: Plant Nutrition, Soil Management, and Integrated Crop Care (10 Hours)

Macro- and micronutrients, deficiency symptoms, and corrective measures. Soil health and management: organic amendments, biofertilizers, composting. Integrated Pest Management (IPM): biological, cultural, chemical, and modern biocontrol approaches. Disease management using biotechnology, molecular markers, and resistant cultivars. Abiotic stress management: drought, salinity, heat, and cold tolerance in horticultural crops.

MODULE IV: Protected Cultivation, Post-Harvest Management, and Value Addition (13 Hours)

Greenhouses, polyhouses, shade nets, and vertical farming.Environmental control: temperature, humidity, light, and CO_2 management.Post-harvest handling: harvesting techniques, storage, grading, packaging, and transport.Value addition: processing, functional foods, nutraceuticals, essential oils, and herbal products. Entrepreneurship and agribusiness opportunities in modern horticulture.

Module 5. TEACH SPACE 15 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5Hrs

Horticultural practices in major crops of Kerala

Practical 10 Hrs

1. Seed treatment, germination tests, and sowing techniques.
2. Vegetative propagation: grafting, budding, layering, and cutting.
3. Nursery bed preparation and plant hardening.
4. Hydroponic and aeroponic system setup.
5. Soil testing and nutrient management exercises.
6. Preparation and application of biofertilizers and organic amendments.
7. Integrated Pest Management exercises (identification, monitoring, biological control).
8. Training and pruning of fruit and ornamental crops.
9. Post-harvest handling: grading, packaging, and storage of fruits and vegetables.
10. Preparation of value-added products: jams, juices, herbal extracts, essential oils.
11. Visit to greenhouse, polyhouse, or commercial nursery.
12. Demonstration of precision horticulture tools (drip irrigation, sensors).
13. Horticultural implements and their uses

Suggested Assignment Topics- Theory

1. Horticultural innovations
2. Principles of Irrigation
3. Pruning in different crops
4. Indian garden systems

Suggested Assignment Topics- Practical

1. Practical of Budding, Layering and Grafting

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bose, T. K., & Mitra, S. K. (1990). *Introduction to Horticulture*. Naya Prokash.
2	Kumar, N. (2018). *Modern Horticulture: Principles and Practices*. Springer.
3	Singh, A. (2016). *Horticulture for Sustainable Agriculture*. New India Publishing.
4	Chrispeels, M. J., & Sadava, D. E. (2003). *Plants, Genes, and Agriculture*. Jones & Bartlett.
5	Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant Physiology and Development* (6th ed.). Sinauer.
6	Chadha, K. L. (2002). *Handbook of Horticulture*. ICAR.
7	Kallarackal, J. J., & Nair, R. K. (2010). *Horticultural Crops of India: Production and Management*. Springer.
8	Singh, D., & Singh, R. (2019). *Advanced Horticulture Techniques*. Wiley.
9	Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2011). *Plant Propagation: Principles and Practices* (8th ed.). Prentice Hall.
10	Craker, L. E., & Simon, J. E. (1991). *Herbs, Spices, and Medicinal Plants: Recent Advances*. Oryx Press.
11	Ravindran, P. N., et al. (2012). *Turmeric: The Genus Curcuma*. CRC Press.
12	Salunkhe, D. K., & Kadam, S. S. (1995). *Handbook of Fruit Science and Technology*. CRC Press.
13	Mahajan, B. V. C., & Ghosh, S. (2009). *Modern Vegetable Production Techniques*.

	Agrobios.
14	Singh, B., & Singh, R. (2017). *Protected Cultivation of Horticultural Crops*. New India Publishing.
15	FAO. (2020). *Good Agricultural Practices for Horticultural Crops*. FAO Publications.
16	Hanan, J. J., & Yelverton, F. H. (2007). *Protected Horticulture and Greenhouse Technology*. Springer.
17	Goldsworthy, P. R., & Fisher, A. D. (2004). *Precision Agriculture and Horticulture*. Elsevier.
18	Pal, R., & Singh, D. (2013). *Post-Harvest Technology of Fruits and Vegetables*. ICAR.
19	Kumar, P., & Singh, S. (2016). *Urban Horticulture and Vertical Farming*. Springer.
20	Tripathi, A., & Chauhan, S. (2018). *Modern Innovations in Horticulture*. Today & Tomorrow's Printers.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal Practical Examination	10

Employability for the Course / Programme

Graduates of this course will be prepared for careers as horticulture officers, nursery managers, agribusiness entrepreneurs, protected cultivation specialists, post-harvest technologists, researchers, and consultants in urban and precision horticulture.

56	Agronomy and Agroforestry		KU6DSCBOT329
DSC	Semester: 6	Hrs/week: 3 Theory + 1 practical	Credits: 4

Course Pre-requisite:

1. Completed any two DSC Botany/Plant Science courses during undergraduation.
2. If there is a requirement of courses to get a minor course Botany/Plant Science.

Course Outcomes	
CO1	Describe the fundamental principles of agronomy including crop physiology, soil-plant-water relationships, cropping systems and productivity.
CO2	Explain the concept of agroecosystems, agroecological principles, biodiversity in agriculture, and ecosystem services in production landscapes.
CO3	Apply modern technologies and innovations in agronomy and agroecology, such as precision agriculture, remote sensing, digital tools and climate-smart practices.
CO4	Evaluate and design sustainable cropping systems, including integrated soil-fertility management, conservation agriculture, agroforestry and intercropping systems.
CO5	Develop skills to analyse, plan and manage crop production systems with ecological, economic and social sustainability in mind.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course is an integrative discipline that explore crop production systems, soil plant environment interactions, and sustainable agricultural practices under changing climatic and socio economic contexts.

- *First module lays the foundation for crop production systems, covering the core agronomic processes including crop physiology, soil plant water relations, tillage, sowing, crop geometry, and the fundamentals of cropping systems.*
- *Second module introduces agroecology—the application of ecological concepts to agricultural systems.*
- *Third module covers innovations such as precision agriculture, digital agronomy, remote sensing/GIS, IoT in farming, and smart monitoring systems.*
- *Focus of fourth module is on nutrient management, soil health, water conservation, and whole system optimisation under sustainability constraints..*

Students will learn modern innovative approaches including remote sensing, precision agriculture, digital agronomy, and agroecological design for sustainable food systems.

Course Objectives:

1. Demonstrate knowledge of crop production processes, soil plant water interactions and agronomic management under different environments.

2. Analyse agroecosystem components and apply agroecological principles to farming systems for enhanced sustainability and resilience.
3. Use modern agronomic tools and technologies (e.g., GIS/remote sensing, precision farming sensors, digital agronomy platforms) to monitor and optimise crop production.
4. Design cropping systems and soil water nutrient management strategies that integrate conservation agriculture, agroforestry or diversification for resilient production.
5. Develop plans for agronomic interventions or agribusiness models that incorporate ecological, economic, social and technological aspects of modern agriculture.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	1	4	3+ 0+ 1 (45+ 0 + 30)	3	25	50	75

COURSE CONTENT

Module I: Foundations of Agronomy (10 Hours) Scope and importance of agronomy; crop production and productivity. Crop physiology: growth, development, yield formation. Soil-plant-water relations: water-use efficiency, irrigation scheduling, root-soil interactions. Tillage, sowing, crop geometry, plant population, seed rate. Cropping systems: crop rotation, intercropping, multiple cropping, fallow systems.
Module II: Agroecology and Sustainable Cropping Systems (12 Hours) Agroecosystem concept; ecological principles in agriculture. Biodiversity in production systems: genetic, species, and landscape diversity. Ecosystem services as applied to cropping systems: pollination, pest regulation, soil health, nutrient cycling. Conservation agriculture, minimum tillage, cover cropping, crop residue management. Agroforestry, crop-livestock integration, sustainable intensification. Climate-smart agriculture, adaptation and mitigation in cropping systems.
Module III: Modern Technologies in Agronomy & Agroecology (11 Hours) Precision agriculture: variable rate fertilizer, yield monitoring, sensors and actuators. Remote sensing and GIS for crop monitoring, stress detection, and mapping. IoT and digital farming platforms: smart irrigation, drones, sensors. Big data, decision support systems, and modelling in agronomy. Bio-based technologies: biofertilisers, biostimulants, microbial inoculants. Emerging topics: vertical farming, controlled-environment agriculture, urban agroecology.
Module IV: Integrated Management of Soil, Water & Nutrients + System Design (12 Hours) Integrated nutrient management: organic, inorganic, bio-fertilisers, nutrient budgeting, recycling. Soil health and microbiome: indicators, management, remediation of degraded soils. Water management: irrigation technologies, water harvesting, deficit irrigation, soil–water–plant relations. System design: cropping system modelling, legumes in cropping systems, intercropping and relay cropping. Sustainability assessment: life-cycle assessment, carbon footprint of cropping systems, socio-economic aspects. Policy, market and value-chain aspects of sustainable cropping systems; resilience to climate variability.
Module 5. TEACH SPACE 15 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and

outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5Hrs

Different types of agroecosystems in Kerala- Wetland Agroecosystems kaippad, prawn farms, paddy fields Plantation ecosystems- Rubber, Coconut

Practical 10 Hrs

1. Seed germination test and seed treatment.
2. Measurement of plant population, spacing and geometry in a crop stand.
3. Soil sampling, texture, moisture, bulk density and infiltration rate measurement.
4. Demonstration of irrigation scheduling and measurement of crop water use (using lysimeters or soil sensors).
5. Variable-rate fertilizer application demo using sensor or map.
6. Remote sensing image interpretation for crop stress (drones or satellite imagery).
7. Setting up a small-plot intercropping/relay cropping experiment; measurement of yield, competition indices.
8. Cover crop and residue management trial; monitoring soil health indicators.
9. Biofertiliser preparation and application; assessment of microbial inoculants on crop growth.
10. Greenhouse or controlled environment module: LED lighting, vertical farming basics.
11. Precision agriculture demo: yield monitor, sensor data collection, IoT device for soil moisture/temperature.
12. Sustainability assessment: carbon footprint calculation of cropping system; cost-benefit analysis of conservation agriculture vs conventional.
13. Field visit to agroecology farm or precision agriculture setup; report and discussion.
14. Use of GIS/Google Earth for mapping field plots and creating variable-rate maps.
15. Laboratory exercise: microbial biomass, soil enzyme activity, and soil health indicators.

Suggested Assignment Topics- Theory

1. Agroecosystems Types
2. Biodiversity of Agroecosystems
3. Monoculture Vs Multiculture
4. Types of agri-vegetations and their biodiversity

Suggested Assignment Topics- Practical

1. Assessment of agrobiodiversity
2. Documentation of agrobiodiversity
3. Agronomic character s

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Altieri, M. A. (2018). *Agroecology: The Science of Sustainable Agriculture* (3rd ed.). CRC Press.
2	Bhattacharyya, R., Lal, R., & Singh, A. (2015). *Sustainable Soil Management: Advances in Soil Science*. Springer.
3	Caldwell, C. D., & Wang, S. (Eds.). (2020). *Introduction to Agroecology*. Springer.
4	Chandrasekaran, B., Annadurai, K., & Somasundaram, E. (Year). *A Textbook of Agronomy*. (PDF available)
5	Ewert, F., & Rötter, R. P. (2013). *Crop Modeling and Decision-Support in Agronomy*. Springer.
6	FAO. (2020). *Good Agricultural Practices for Sustainable Cropping Systems*. Food and Agriculture Organization.

7	Gandini, A., … (2022). *Cropping System Simulation and Modelling: Tools for Agronomy & Ecology*. Springer.
8	Gliessman, S. R., Méndez, V. E., Izzo, V. M., & Engles, E. W. (2023). *Agroecology: Leading the Transformation to a Just and Sustainable Food System* (4th ed.). Routledge.
9	Govaerts, B., & Sayre, K. (2015). *Conservation Agriculture: Practices and Benefits*. CABI.
10	Hecht, S. B., & Hall, P. (2019). *Agroforestry Systems: Productivity and Sustainability*. Springer.
11	Kumar, R., & Yadav, S. (2020). *Fundamentals of Agronomy*. AkiNik Publications.
12	Miller, R., & Gardiner, M. (2021). *Digital Agriculture: Precision, Data & AI in Farm Management*. Wiley.
13	Müller-Plath, G., & Schloter, M. (2014). *Soil Microbiology, Ecology and Biochemistry* (4th ed.). Academic Press.
14	Pretty, J., & Bharucha, Z. P. (2014). *Sustainable Intensification in Agricultural Systems*. Routledge.
15	Reddy, T. Y., & Reddy, G. H. S. (2016). *Principles of Agronomy* (2nd ed.). Kalyani Publishers.
16	Reinke, R., & Izzo, V. (2020). *Climate-Smart Agriculture: Strategies for Resilience and Sustainability*. Cambridge University Press.
17	Sauerborn, J., & Martin, K. (2013). *Agroecology*. Springer.
18	Singh, J. S., & Kushwaha, C. P. (2010). *Forest Ecosystem: Structure and Function*. Springer.
19	Villalobos, F. J., & Fereres, E. (Eds.). (2016). *Principles of Agronomy for Sustainable Agriculture*. Springer.
20	Walker, B., & Schluter, D. (2018). *Biodiversity and Ecosystem Functioning in Agroecosystems*. Oxford University Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits and Lab analysis	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	**65**
• University Examination	50
• Practical Examination	15
Continuous Comprehensive Assessment CCA	**35**
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10
• Internal Practical Examination	10

Employability for the Course / Programme

With the integration of modern technologies and sustainable frameworks, graduates will be equipped to work in agricultural technology firms, consultancy services, research institutions, government agriculture departments, start-ups in digital farming, and sustainable food systems enterprises.

1	Plant Diversity		KU1MDCBOT101
MDC	**Semester : 1**	**Hrs/week: 3 Theory**	**Credits : 3**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Acquisition of basic knowledge in botany.
CO2	Understanding of the major terms used in botany and the way of scientific description of diverse forms of life.
CO3	Understanding the basic differences that exist among diverse groups of plants.
CO4	Ability to apply the concepts gathered in this course to move forward in botanical studies.
CO5	First-hand experience in viewing the diversity using laboratory procedures and there by induction of enthusiasm in biological studies.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√		√	√						
CO3						√						
CO4									√	√		
CO5											√	√

Course Description
This is an introductory biology course designed for all UG students who are interested in botanical studies in future and presently are having a shallow knowledge in the field of biology. The aim of the course is to give basic knowledge about botany and the diversity of plant life forms.
• *First module gives details on branches of botany* • *Second module focuses on the classification of plants* • *Third module gives a detailed account on vegetative morphology of angiosperms.* • *Fourth module is a brief account on the reproductive morphology of angiosperms.*
This course will also provide opportunities to observe diverse forms of plant life of lower groups including fungi, during theory and laboratory sessions designed by the teacher.

Course Objectives:

1. Understanding of the fundamental nature of science, namely botany.
2. Concept development in identification, description and classification of plants.
3. Enable the student to appreciate bio diversity for sustainable development.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/entrepreneurship.

Credits			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	45	25	50	75

COURSE CONTENT

Module 1. Botany as a science 8hrs

Botanical History: Contributions of eminent botanists: Theophrastus and Carl Linnaeus. Indian contributors- Itty Achudan and Van Rheed. E K Janaki Ammal, M S Swaminathan. Plants and their value- economic-food and fibre, timber- both natural and processed; medicinal- drugs and medicines; aesthetic - in gardening and landscaping; ecological - Producer and habitat for several organisms.

Module 2. Classification of Plants 6 hrs

Herbs, shrubs, trees, climbers, creepers, twiners, epiphytes and parasites. Annuals, biennials, and perennials.

Distinguishing features of major plant groups with an emphasis to vegetative morphology and prominent reproductive features- Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

Module 3. Vegetative morphology of Angiosperms 6hrs

Roots- Morphological Structure, function and Modifications-tubers (carrot), prop root (*Ficus*), stilt root (*Rhizophora*) and pneumatophores (*Avicennia*)

Stem- Morphological Structure –node- internode; Modifications- phylloclade (*Opuntia*), cladode (*Asparagus*), tuber (potato), rhizome (ginger).

Leaves- Basic morphology- Phyllotaxy- alternate, opposite, whorled. Venation- Parallel and reticulate. Modifications.

Module 4. Reproductive morphology Angiosperms 10 hrs

Flower- parts- calyx, corolla, androecium, gynoecium. Trimerous, tetramerous and pentamerous flowers with examples. Aestivation - Valvate (in calyx- *Hibiscus*) Twisted (in corolla- *Hibiscus*), Vexillary (*Clitoria*).

Inflorescence – Racemose, Cymose, Special and Mixed types. Raceme – in *Crotalaria*, *Caesalpinia*, Sunflower, *Anthurium*, Coconut. Cymose- Jasmine and *Hamelia*. Special- *Euphorbia*, *Ficus*. Mixed- *Ocimum*, *Clerodendrum panniculatum.*

Fruits- Simple- Berry- Tomato; Drupe- Coconut; Aggregate- *Polyalthia*; Multiple fruit- Jack fruit.

Seeds- General structure. Dicot and Monocot. Germination- Hypogeal and epigeal germination.

Module 5: TEACH Space 15 hrs (Only suggested list of topics and activities; that helps to achieve the aim, objectives and outcome of the course, which can be finalized by the concerned teacher. Assessment for this module is ***strictly internal***.)

Research potentials in Botany 2 hrs

Branches in Botany- Taxonomy, Morphology, Anatomy, Physiology. Pure and Applied Branches. Interdisciplinary and Multidisciplinary branches- with major applications of these branches.

Brief Account and Research potentials in: Plant systematics, Ecology, Plant anatomy, Plant physiology, Genetics, Ethnobotany, Crop improvement & Plant genetic engineering.

Practicals 13 hrs. This module is a list of suggested activities; which will be determined by the concerned teacher.

1. Reading on *Hortus Malabaricus*, Contributions of E K Janaki Ammal, Green revolution, and Life history and achievements of MS Swaminathan.
2. Observation of diversity in vegetative characters in the premises.

3. Documentation of diversity in flowers, inflorescences, fruits and seeds; in the premises.
4. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Gangulee, S.C., Das, K.S., Dutta, C.D., & Kar, A.K., (1968). College Botany Vol. I, II and III. Central Education Enterprises.	1, 2, 3, 4
2	Manilal, K.S. (2003). *Van Rheede's Hortus Malabaricus. English Edition*, with Annotations and Modern Botanical Nomenclature. (12 Vols.) University of Kerala, Trivandrum.	1
3	Iyer R D, 2021. M S Swaminathan	1
4	Dutta A C, (2000). A class book of botany, Oxford University Press.	1, 2, 3, 4
5	Suresh Narayana P and T. Pullaiah, 2021. Eminent Indian Botanists: Past and Present Biographies and Contributions, Regency Publications.	1
Core Compulsory Readings		
1	Baker. H.G. 1970. Plant and Civilization, Wadsworth Publishing Company	
2	Hait, G., 2023. Introductory Botany Vol – II, Asian Humanities Press, Global net Publication.	
3	Hait, G., 2024. INTRODUCTORY BOTANY - II : Morphology and Reproduction of Spermatophytes, Asian Humanities Press, Global net Publication.	
Core Suggested Readings		
1	Starr, C., (2007). Biology: concepts and applications. VI edn. Thomson Press.	
2	Raven, P.H., Evert, R.F., & Eichhorn, S.E., (2013). Biology of plants. VIIIth Ed. W.H. Freeman Publishers.	

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question

- What are the two main types of cells, and what distinguishes them from each other?
- List out any four features of fluid mosaic model of the cell membrane and its significance in cell biology.
- Differentiate pit from pit fields
- What are the functions of plant roots?
- Differentiate phycobiont from mycobiont with examples

3 Marks Questions (Applying and Analyzing):

- Using a diagram, illustrate the structure of a plant cell wall and explain its functions.
- The distribution and structure of chloroplast helps in the functioning of photosynthesis. Substantiate.
- Analyze the implications of the endosymbiotic theory for our understanding of cellular evolution.
- Explain the vegetative thallus of ascomycete fungi.

5 Marks Questions (Evaluating and Creating):

- Evaluate the impact of advancements in cell biology on modern scientific research and technology.
- Knowledge in biodiversity is highly essential for the economic growth and human welfare. Substantiate the statement.

Employability for the Course / Programme

It is one of the basic courses in botany that is very helpful in understanding the fundamental concepts in botany, diverse forms of plant life and their description as well as classification. It is one of the course designed for a better start of a botanical journey in academics.

2	**Botany for the Beginners**		**KU1MDCBOT102**
MDC	**Semester : 1**	**Hrs/week: 3 Theory**	**Credits : 3**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Basic knowledge in botany
CO2	Understanding of the terms, concepts and basic nature of botany and its applications in human welfare.
CO3	Understanding the Ecological relations of plants.
CO4	Application of the concepts of botany and knowledge in plant diversity in future activities and also for the profession.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√		√	√						
CO3						√						
CO4									√	√		

Course Description
This is a foundation course in botany designed for all UG students in general with an aim to give basic knowledge about plants, their diversity and diverse applications in human welfare.
• *First module is emphasizing on the general classification of living forms.* • *Second module is dealing with the description and classification of higher plants.* • *Third module delves into the ecological roles of plants.* • *Fourth module is giving an idea on the application of plant into various aspects of human life.*
This course will also provide opportunities to observe diverse forms of plant life within the premises and will help to widen the knowledge in botany.

Course Objectives:

1. Understanding of the fundamental concepts in Botany.
2. Concept development in description and classification of plants.
3. Enable the student to appreciate bio diversity, sustainable development with the help of their core subject and subsidiary subject botany.
4. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/enterpreneurship

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	45	25	50	75

CONTENT

Module 1. Living world *6 hrs*

Concept of Living and Non Living: Origin of Life. Viruses, Bacteria, Fungi, Plants and Animals; Five kingdom Classification. General characters of major plant groups- Algae, Bryophytes, Pteridophytes, gymnosperms and angiospersm. Life cycle of angiosperms plants.

Module 2. Major features of Angiosperms *6 hrs*

Typical angiosperm plant: Functions of each organ viz. Root, Stem, leaves, inflorescence, flowers, fruit and seed.

Flower: Basic structure - essential and non essential whorls. Trimerous, tetramerous and pentamerous flowers with examples. Aestivation - Valvate (in calyx- *Hibiscus*) Twisted (in corolla- *Hibiscus*), Vexillary (*Clitoria*).

Inflorescence – Racemose, Cymose, Special and Mixed types. Raceme – in *Crotalaria*, Sunflower, Cymose- Jasmine. Special- *Ficus*. Mixed- *Ocimum.*

Fruits- Simple- Berry- Tomato; Drupe- Coconut; Aggregate- Polyalthia; Multiple fruit- Jack fruit.Seeds- General structure. Dicot and Monocot.

Module 3. Ecological role of plants *8hrs*

Ecological Significance of Plants – Solar energy fixing Producers and Nitrogen fixation, Symbiotic relationships of plants – Lichens, Azolla and Blue green alga, Parasitism.

Plants and Animals for pollination and seed/fruit dispersal- Pollination- Entomophily, Chiropterophily, Myrmecophily. Seed Dispersal: Zoochory,

Specific case studies on examples for co evolution- Dodo and Calvaria, Butterflies and plants; Wasps and Ficus, mimicking for pollinators.

Module 4. Applications of Plant biology *10Hrs*

Agriculture-Crop improvement-weed control and management-Integrated pest management-plant propagation- intercropping- crop rotation- biofertilisers, biopesticides, Plant breeding-Medicine-Plant derived drugs in various systems of medicine- netraceuticals and pharmaceuticals.

Environmental management- Gardens and biodiversity conservation- Productivity and role in biogeochemical cycling. Green corridors and belts

Module 5. TEACH Space **(1 5 hrs):**

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Collection, documentation and observation of plants in the premises.
2. Collection of information on role of plants in various aspects of human life.
3. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Group wise characters of plants
2. Life cycle of plants

Suggested Assignment Topics- Practical

1. Photographs of different plants in the premises
2. Microphotographs of all practical works
3. Collection documentation and classification of diverse forms of plant life

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Hait, G., 2023. Introductory Botany Vol – I, Asian Humanities Press, Global net Publication.	1, 2, 3,4
2	Sen K and P Giri, 2024. Fundamental Botany, Santra Publication Pvt Ltd	4
3	Dutta A C, (2000). A class book of botany, Oxford University Press.	1, 2, 3, 4
4	Gangulee, S.C., Das, K.S., Dutta, C.D., & Kar, A.K., (1968). College Botany Vol. I, II and III. Central Education Enterprises.	1, 2,3, 4
Core Compulsory Readings		
1	Hait, G., 2023. Introductory Botany Vol – II, Asian Humanities Press, Global net Publication.	
2	Hait, G., 2024. INTRODUCTORY BOTANY - II : Morphology and Reproduction of Spermatophytes, Asian Humanities Press, Global net Publication.	
Core Suggested Readings		
1	Starr, C., (2007). Biology: concepts and applications. VI edn. Thomson Press.	
2	Raven, P.H., Evert, R.F., & Eichhorn, S.E., (2013). Biology of plants. VIIIth Ed. W.H. Freeman Publishers.	

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question

➢ What are the major features Kingdom Protista

➢ Define Primary Productivity

3 Marks Questions (Applying and Analyzing):

➢ Alga is a synthetic term to denote organisms belonging to different plant groups. Analyse.

➢ Basic knowledge about plants helps in improving human welfare. Give a short note.

5 Marks Questions (Evaluating and Creating):

➢ Plants are the dominating component of any ecosystems, that plays a key role in shaping of ecosystems. Critically evaluate.

Employability for the Course / Programme

It is one of the foundation courses which is very helpful in understanding the diversity of plant life and its application in various aspects of human life.

3	**Beginner's Exploration to the world of leaves and flowers**		**KU2MDCBOT103**
MDC	**Semester : 2**	**Hrs/week: 3 Theory**	**Credits : 3**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Ability to identify and describe the external morphology of a leaf and its parts.
CO2	Appreciation of the significance of leaves in plant identification and classification.
CO3	A comprehensive understanding the structure and function of flower and floral parts.
CO4	Acquisition of basic knowledge in the stages of reproduction in flowering plants and their importance in plant life cycles.
CO5	Ability to integrate their knowledge on leaf morphology, flower structure, and reproductive biology for further understanding of biology and ecology.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**	**PSO11**	**PSO12**
CO1	√	√	√									
CO2		√		√								
CO3					√	√						
CO4							√		√			
CO5											√	√

Course Description
This is a foundation course designed for UG students in general and for BSc Zoology, BSc Microbiology and BSc Forestry in particular. This course provides a foundational understanding of structure, function and diversity among leaves and flowers into various studies in botany, ecology, and related fields and also for the application in bouquet making and other interior decorations.
• *First module identifies and describes the external morphology of a leaf, including the blade (lamina), petiole, stipules, and veins.* • *The second module provides an overview of the significance of leaves in plant identification and classification.* • *The third module focuses on the structure and function of flowers.* • *The fourth module covers flower development and reproduction.*
In this course, participants have the opportunity to delve into a wide array of plant leaves and flowers.

Course Objectives:

1. To identify different types of plant leaves and flowers based on their unique characteristics.
2. To get a basic knowledge in classification of flowers and leaves based on their structures, functions, and other features.

3. To appreciate the vast diversity present in plant leaves and flowers, recognizing the range of shapes, sizes, colors, and adaptations that exist in the plant kingdom.
4. to apply their knowledge of plant leaves and flowers in real-world contexts, such as gardening, landscaping, bouquet making, interior decorations and plant conservation efforts.

Credit			**Teaching Hours**		**Assessment**		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	45	25	50	75

COURSE CONTENT

Module 1: Basics of Leaf Structure, Function, and Diversity 8 hrs

External Structure: Blade (Lamina), Petiole, Stipules and Veins.

Leaf Arrangements: Alternate, Opposite, Whorled: Leaf Diversity: Leaf Types: Simple Leaves: Compound Leaves: Leaf Shapes: Elliptical, Lanceolate, Ovate. Leaf Margins: Entire, Serrated, Lobed. An overview of leaf apices.

Internal Structure: Epidermis, Mesophyll, Palisade Mesophyll, Spongy Mesophyll and Stomata.

Module 2: Leaf Diversity for various uses 8 Hrs

Role of Leaf in plant Life: Photosynthesis, Gas Exchange, Transpiration, Guttation, Storage, Protection. Leaf Senescence and Colour changes during development with examples. A brief account on leaf pigments. Dye yielding leaves. Modifications of leaves. Reproduction from leaves. Modern methods of propagation using leaves. Leaf spray in agriculture and horticulture. Significance of Phylloplane and Phyllosphere..

Significance of Leaf study in various fields. Adaptations and leaves. Evolution and leaves. Taxonomy and Leaves. Role in Ecosystem Dynamics- Allelopathy, Humus formation and Soil biodiversity. Medicinal and cultural uses of leaves.

Module 3. Sex organ of angiosperms – the flower: Structure and Function 6 hrs Parts of a flower. Various types of flowers- based on symmetry, position of ovary, number of floral units, complete or incomplete, cohesion and adhesion.

Inflorescences- Racemose, Cymose and Special and Mixed. Special structures – Bracts, Bracteoles.

Fruits and seeds the end products of sexual reproduction.

Module 4. Flower Development and Reproduction- 8 Hrs

Flower/ inflorescence development stages: From bud to Anthesis, Pigments in flowers. Colour changing flowers. Adaptations for attraction of pollinators.

Fruit/Seed development and Fruit ripening and colour change. Diversity in dispersal of fruits and seeds.

Pollinators and Pollination mechanisms. Floral mimicry and deception. Fruit and seed dispersal and germination mechanisms with an emphasis to zoochory and germination with the help of animals. Case study- Rafflesia and elephant, Loranthus and Birds, Calvaria and Doddo.

Economic significance of flowers: Agriculture, horticulture, and floriculture. Medicinal and cultural uses of flowers.

Module 5. TEACH Space (15 hrs):

Theory: 5 hrs

Importance of leaves and flowers/inflorescence in various decorations- vase, wreath, garlands, stage arrangements, arch makings. Making methods. An overview of major flowers and leaves used in decorations- live and dead/preserved. Methods to increase the longevity and prevention of senescence. Wet and dry methods of preservations. Local case studies – during religious customs and ritual practices.

PRACTICALS 10 hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Microscopic observation of internal structure of leaf.
2. Observation and collection of different types of leaves.
3. Ecological variation in leaves.
4. Dissect out diverse flowers.
5. Students observe pollination in action by observing flowers in the college campus.
6. Organize symposium and workshops on floral decoration /bouquet making.
7. Visits to local farms or floral markets.

Suggested Assignment Topics- Theory/Practical

1. Leaf Morphology Comparative Analysis
2. Leaf Function Experiment Report
3. Leaf Diversity Field Guide
4. Taxonomic Classification Project
5. Ecosystem Dynamics Case Study
6. Leaf Identification Challenge
7. Flower Dissection Lab Report
8. Pollinator Observation Field Journal
9. Flowering Plant Life Cycle Diagram
10. Flowering Plant Classification Poster
11. Economic Importance of Flowers Presentation

Suggested readings specific to the module.		
Sl. No	**Title/Author/Publishers of the Book specific to the module**	**Module No.**
1	Ollerton J, 2020. Pollinators and Pollination: Nature and Society, Pelagic Publishing	4
2	Hait, G., 2023. Introductory Botany Vol – I, Asian Humanities Press, Global net Publication.	1, 2, 3,4
3	Sen K and P Giri, 2024. Fundamental Botany, Santra Publication Pvt Ltd	1, 2, 3, 4
4	Dutta A C, (2000). A class book of botany, Oxford University Press.	1, 2, 3, 4
5	Gangulee, S.C., Das, K.S., Dutta, C.D., & Kar, A.K., (1968). College Botany Vol. I, II and III. Central Education Enterprises.	1,2, 3, 4
Core Compulsory Readings		
1	"Botany for Gardeners: An Introduction and Guide" by Brian Capon	
2	"The Botany of Desire: A Plant's-Eye View of the World" by Michael Pollan	
3	"Plant Systematics: A Phylogenetic Approach" by Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellogg, and Peter F. Stevens	

4	"Botany in a Day: The Patterns Method of Plant Identification" by Thomas J. Elpel
5	"The Hidden Life of Trees: What They Feel, How They Communicate – Discoveries from a Secret World" by Peter Wohlleben
6	"Indian Herbalogy of North America: The Definitive Guide to Native Medicinal Plants and Their Uses" by Alma R. Hutchens
7	"Flowers of India" by Dinesh Valke
8	"The Book of Indian Trees" by K. C. Sahni
9	"Indian Medicinal Plants: An Illustrated Dictionary" by C.P. Khare
10	Natália O. Leiner, André R.T. Nascimento and Céline Melo Plant Strategies For Seed Dispersal In Tropical Habitats: Patterns And Implications - Tropical Biology And Conservation Management – Vol. I - Encyclopedia of Life Support Systems (EOLSS)
Core Suggested Readings	
1	Abrol D P, 2012. Pollination Biology: Biodiversity Conservation And Agricultural Production, Springer.
2	Roberto Caballero, Elizabeth V. Reyes and Luca Invernizzi Tettoni, 2012. Decorating with Flowers: A Stunning Ideas Book for all Occasions, Tuttle Publishing.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group Discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question

1. How do the blade (lamina), petiole, stipules, and veins contribute to the external morphology of leaves?
2. What are the main components of leaf internal anatomy, and how do they facilitate leaf functions?
3. When might leaves exhibit different types of arrangements such as alternate, opposite, or whorled?
4. What are the primary functions of leaves, including photosynthesis, gas exchange, transpiration, storage, and protection?
5. How do simple and compound leaves differ, and what are some examples of each type
6. How do leaf shape and size serve as key identifying features in plant classification?
7. What are venation patterns in leaves, and when are they used for classification?
8. When are apex/base shapes of leaves important in identifying plant species

9. What is the significance of taxonomic classification in identifying plant families and genera?
10. Why are stamen, pistil, petals, and sepals essential reproductive structures in flowers?
11. When do flowers typically utilize wind, water, insects, and animals for pollination?
12. How do flowers adapt to different pollination mechanisms?
13. What are the stages of flower development from bud to fruit?
14. Why is it important to differentiate between pollination and fertilization in flower reproduction?
15. When does seed development and dispersal typically occur in the life cycle of a flowering plant?
16. How do adaptations in flowering plants contribute to their survival and reproduction

3Marks Questions (Applying and Analyzing):

1. Identify and describe the external morphology of a leaf, including the blade (lamina), petiole, stipules, and veins.
2. Explain the internal anatomy of a leaf, including the epidermis, mesophyll (palisade and spongy), and stomata.
3. Understand the functions of leaves, including photosynthesis, gas exchange, transpiration, storage, and protection.
4. Recognize different leaf types, such as simple and compound leaves.
5. Identify various leaf shapes, including elliptical, lanceolate, and ovate.
6. Describe different leaf arrangements, such as alternate, opposite, and whorled.
7. Differentiate between various leaf margins, including entire, serrated, and lobed.

5 Marks Questions (Evaluating and Creating)

1. Describe in detail the external morphology of a leaf, highlighting the significance of the blade (lamina), petiole, stipules, and veins. Explain how variations in these structures contribute to leaf diversity.
2. Discuss the internal anatomy of a leaf, including the epidermis, mesophyll (palisade and spongy), and stomata. Explain how each component facilitates leaf functions such as photosynthesis, gas exchange, and transpiration.
3. Compare and contrast simple and compound leaves, providing examples of each type and explaining their structural differences and potential advantages in various environments.
4. Analyze the diversity of leaf shapes, including elliptical, lanceolate, and ovate. Discuss the adaptive significance of different leaf shapes in relation to environmental factors and ecological niches.
5. Evaluate the importance of leaf arrangements, such as alternate, opposite, and whorled, in plant physiology and ecology. Discuss how different arrangements may reflect adaptations to specific environmental conditions.
6. Explain how leaf shape and size, leaf arrangement, and venation patterns serve as key identifying features in plant classification. Provide examples of how these features are used to classify different plant species.
7. Discuss the significance of taxonomic classification in plant biology, focusing on its role in identifying plant families and genera. Explain how taxonomic classification reflects evolutionary relationships among plants.

8. Analyze the functional adaptations of leaves to different environmental conditions, including structural modifications and physiological processes. Discuss how these adaptations enhance plant survival and reproduction.
9. Evaluate the ecological importance of leaves in ecosystem dynamics, including their role in primary productivity, nutrient cycling, and habitat provision. Provide examples of how leaves contribute to ecosystem services and biodiversity.
10. Discuss the potential impacts of environmental changes, such as climate change and habitat loss, on leaf diversity and plant communities. Evaluate strategies for conserving leaf diversity and promoting sustainable plant ecosystems.

Employability for the Course / Programme

"A Beginner's Exploration to the World of Leaves and Flowers" provides a gateway to various career paths within the realm of botany, horticulture, and environmental education. Graduates can find employment as botanical technicians, gardening assistants, floral designers, and nature educators, utilizing their knowledge of leaves and flowers to contribute to plant research, landscape design, and environmental advocacy.

4	Agrobiodiversity		KU2MDCBOT104
MDC	Semester : 2	Hrs/week: 3 Theory	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10^{th} Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Basic knowledge in agro-biodiversity.
CO2	Understanding the historical context of plant and animal domestication.
CO3	Appreciation of the ecological benefits provided by agro-biodiversity.
CO4	Recognition of the critical role of agro-biodiversity in ensuring food security, nutrition, and its economic and cultural significance in agricultural systems.
CO5	Understanding of the importance of agro-biodiversity in sustainable agricultural practices, fostering resilience and environmental sustainability in farming systems.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	POS8	POS9	POS10	POS11	POS12
CO1	√	√	√									
CO2			√		√							
CO3				√	√		√					
CO4								√	√			
CO5										√	√	√

Course Description
This course explores the variety and variability of plants, animals, and microorganisms used directly or indirectly for food and agriculture. It covers the concepts, importance, and conservation strategies of agro-biodiversity, focusing on sustainable agricultural practices and the impact of modern agricultural techniques.
• *First module covers the fundamentals of Agro-biodiversity Introduction.* • *The second module focuses on assessment and Threats to Agrobiodiversity.* • *Third module deals with Sustainable Agricultural Practices* • *Fourth module covers Modern Agricultural Technologies*
In addition, this course offers practical sessions on model organisms, providing you with opportunities to explore a wide range of angiosperms and their diversity. By combining theoretical learning with hands-on experiences, the course offers a structured approach to comprehending agro-biodiversity, ensuring a holistic understanding of the subject matter.

Course Objectives:

1. Understand the concept and components of agro-biodiversity.
2. Recognize the importance of agro-biodiversity in sustainable agriculture.
3. Identify the threats to agro-biodiversity and strategies for its conservation.
4. Explore traditional and modern agricultural practices and their impact on agro-biodiversity.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	45	25	50	75

COURSE CONTENT

Module 1: Introduction to Agro-biodiversity 8Hrs

Definition and scope of agro-biodiversity, Components of agro-biodiversity: Genetic, species, and ecosystem diversity, Historical perspective on the domestication of plants and animals, Importance of Agro-biodiversity- Role in food security and nutrition, Ecological benefits: Soil health, pollination, pest and disease control, Economic and cultural significance. Rice varieties of Kerala and contribution of Cheruvayal Raman.

Module 2: Assessment and Threats to Agrobiodiversity 12 Hrs

Methods and tools for measuring agro-biodiversity, Species Richness, Genetic Diversity, Ecosystem Diversity, Agro-Ecological Methods. On-farm conservation vs. ex-situ conservation- On-farm Conservation-definition, advantages, challenges. Ex-situ Conservation: Conservation-definition, advantages, challenges. Modern agricultural practices: Monocultures, use of pesticides and fertilizers, Climate change and its impact, Habitat loss and degradation

Module3: Sustainable Agricultural Practices- Organic farming 5 Hrs

Agroforestry and Crop rotation and polycultures. Traditional Knowledge and Agro-biodiversity- Indigenous farming practices, Role of traditional knowledge in conservation, Case studies from different regions. PPVFRA and Concept of Genomic Saviours- Shaji -the tuber saver. Praseed Kumar Thayyil and Sunil Kumar M. of Wayanad district. John Joseph of Kozhikode district and Vinod E.R of Thrissur district.

Module 4. Modern Agricultural Technologies for Agrobiodiversity Management 5 Hrs GMOs and their impact on agro-biodiversity- Genetic erosion. Agricultural biodiversity management Strategies- Good agricultural practices to manage agricultural biodiversity- Species-based conservation- Area-based conservation- Ecosystem approaches- Creating a supportive environment- Improving the practice of conservation on the ground.

Module 5. TEACH Space (15 hrs):

Theory- 5 hrs
Successful agro-biodiversity conservation projects. Local initiatives- Kuttiattoor Geotagged Mango. Kannapuram and Kunhimangalam Mango movements. Shimjith Thillenkery and Curcuma varieties. Ezhome Rice Project.

Practical-10 hrs
Field Visits and Practical Work- Visits to local farms, botanical gardens, or research institutions. Hands-on activities: Seed saving, soil health assessment,biodiversity surveys

Sl. No	Title/Author/Publishers of the Book specific to the module
1	D. I. Jarvis, C. Padoch, and H. D. Cooper- "Agrobiodiversity: Managing Biodiversity in Agricultural Ecosystems"
2	Food and Agriculture Organization - "The Role of Biodiversity in Agriculture: Report of an FAO/UNEP Expert Consultation"
3	P. S. Teng - "Seeds of Sustainability: Lessons from the Birthplace of the Green Revolution in Agriculture"
4	S. K. Sharma, K. S. Varaprasad, P. S. S. Rao, S. A. Tarafdar, 2019. "Agrobiodiversity Hotspots: Concepts, Conservation and Management" Springer.
5	A.K.Kandya, 2015. "Agrobiodiversity and Sustainable Rural Livelihoods", Scientific Publishers.
6	P. R. Seshagiri Rao, 2004. Agrobiodiversity in India", Concept Publishing Company.
7	T. C. James, 2008. "Agricultural Biodiversity, Biotechnology and Traditional Knowledge: Biological and Legal Correlations", Academic Foundation.
8	B. S. Dhillon, B. S. Rana, R. K. Tyagi, 2002. "Managing Agrobiodiversity: Farmers' Changing Perspectives and Institutional Responses in the Hindu Kush-Himalayan Region", International Centre for Integrated Mountain Development (ICIMOD).
9	R. S. Rana, R. K. Tyagi, T. J. H. Renault, 1997. "Conserving Agricultural Biodiversity: The IPGRI Programme in Asia, the Pacific and Oceania", International Plant Genetic Resources Institute (IPGRI).
10	M.S. Swaminathan, 1996."Agrobiodiversity and Farmers' Rights", Konark Publishers Pvt. Ltd.
11	M.S. Swaminathan,2004. "Agrobiodiversity and Sustainable Agriculture", Academic Foundation.
12	M.S. Swaminathan and S. L. Kochhar, 2000. "Biodiversity and Sustainable Food Security: Exploring the Links", Macmillan India.
13	Nayar, N M (2011), “Agrobiodiversity in a biodiversity hotspot: Kerala State, India. Its origin and status”, Genetic Resources and Crop Evolution, 58(1):55-82
14	Sunil Mani, S M Mohanakumar, V Santhakumar and T Abhilash, Conservation of Agrobiodiversity: Lessons from Kerala. *https://practiceconnect.azimpremjiuniversity.edu.in/conservation-of- agrobiodiversity-lessons-from-kerala*

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question
1. What is agro-biodiversity?
2. What are landraces?
3. When is the International Day for Biological Diversity celebrated?
4. When did the Convention on Biological Diversity come into force?
5. Why is agro-biodiversity important for food security?
6. Why should traditional farming practices be preserved?
7. How can farmers contribute to the conservation of agro-biodiversity?
8. How does climate change impact agro-biodiversity?

3 Marks Questions (Applying and Analyzing):
1. Explain the role of agro-biodiversity in enhancing ecosystem services in agricultural landscapes.
2. Analyze the impact of monoculture practices on agro-biodiversity and suggest alternative practices that could mitigate these impacts.
3. Discuss how traditional agricultural knowledge contributes to the conservation of agro-biodiversity and provide an example.
4. Evaluate the effectiveness of in-situ conservation methods for agro-biodiversity compared to ex-situ conservation. Provide examples to support your evaluation.
5. How does agro-biodiversity contribute to climate change mitigation and adaptation in agricultural systems?

5 Marks Questions (Evaluating and Creating):

1. Evaluate the impact of global agricultural policies on agro-biodiversity and propose policy changes that could promote the conservation and sustainable use of agro- biodiversity.
2. Design a comprehensive community-based program to enhance agro-biodiversity in a rural agricultural setting. Outline key components, stakeholder roles, and expected outcomes.
3. Critically assess the role of modern biotechnology in agro-biodiversity conservation. Include potential benefits and risks, and suggest strategies for integrating biotechnology with traditional conservation methods.
4. Evaluate the role of agro-biodiversity in sustainable food systems and propose a model for integrating agro-biodiversity into urban agriculture.

Employability for the Course / Programme

This foundation course on agro-biodiversity offers students a comprehensive understanding of the intricate relationships between agriculture, biodiversity, and sustainability. By delving into topics such as genetic diversity, ecosystem services, and conservation strategies, students gain valuable insights into the importance of maintaining diverse agricultural systems for food security and environmental resilience. Armed with this knowledge, graduates are well-prepared to pursue diverse career paths, from agricultural research and conservation to policy development and sustainable farming practices, thereby contributing significantly to the global efforts towards a more sustainable and biodiverse agricultural future.

5	Botanical Art		KU3MDCBOT105
MDC	Semester: 3	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understanding of various types of documentations relevant to Botany.
CO2	Skill in Botanical illustrations, Handicraft making, Photography techniques and making of herbarium
CO3	Application of various skills and knowledge in life situations
CO4	Appreciation of the use of plant parts in various handicrafts
CO5	Designing of new handicrafts and illustrations using plants

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This is an introductory biology course designed for all UG students who are interested in botanical studies in future and presently are having a shallow knowledge in the field of biology. The aim of the course is to give basic knowledge about botany and its applications as an art.

- *First module is dealing with various types scientific illustration including botanical illustrations*
- *Second module is giving the information on Herbarium making*
- *Third module is composed of knowledge and understanding of various plant related handicrafts*
- *Fourth module is giving a direction towards photography.*
- *Fifth module is an innovative space for teachers and students.*

This course will provide you opportunities to observe diverse forms of botanical arts along with practical sessions on various forms of botanical art and documentations,

Course Objectives:

1. Understanding of the fundamental concepts in classification of plants.
2. Concept development in structure and reproduction of lower plants.
3. Enable the student to appreciate bio diversity, sustainable development with the help of their core subject and subsidiary subject botany.
4. Explore traditional and modern documentation methods in botany.

5. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/entrepreneurship

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Botanical illustration 10 Hrs

1.1 Scientific illustration- the world of Visual Science. Introduction and history- cave paintings of Paleolithic era. Anatomical illustrations of Herophilus. Botanical illustrations in *Hortus Malabaricus*.

1.2. Brief account on various types of scientific illustrations- Natural History illustrations and mappings, Restoration and illustration of extinct species, Forensic reconstruction of facial structures, Botanical illustrations, Models and images for Museum Exhibits, Infographics. Digital 3D models, animations and Videos. AI tools for Scientific illustration. Canva, Inkscape and Vectr.

1.3. Types of botanical illustrations. Basic characters and differences between the types- Botanical illustration, Botanical art, Flower paintings and plant portraiture. Tools and techniques. Pencil/Charcoal technique, Lavy ink technology, Water color, Gouache technique, Ecoline and Mixed types

1.4. Relevance and Significance of Scientific Illustrations: Advantages of botanical illustration over modern digital documentations and photographs. Linnaean Society of London and Jill Smithies Award.

Module 2: Herbarium art 5 Hrs

2.1. Herbarium-Introduction, Types of Herbaria- International, National, Local and Special with examples.

2.2. Tools and techniques used in process of making herbaria- Field visits and specimen collection, preparation, pressing, drying, poisoning, mounting, identification, labelling, cataloguing and storage.

2. 3. Major herbariums in India & world: Role and Importance of Herbarium. -Scientific & Aesthetic.

2.4. Merits and Demerits of conventional Herbaria. Electronic / Digital herbarium- merits and demerits

Module 3: Plants and Handicrafts 5 Hrs

3.1 An introduction to relevance of plants in Handicraft making- Timber and non timber plants.

3.2. Conventional and modern innovative techniques and types of Handicrafts. Major plant parts used in handicraft making case studies – root, stem, leaf, inflorescence, Flower, Fruit and Seeds. Vegetable printing and carving. Seed jewellery.

3.3., Interior decoration- various styles and their comparative account. Domestic, office, industry. Conventional occasions of interior decoration using plants. Modern life style and importance of plants in decoration.

3.4. Plant based handicraft industry in Kerala- conventional and modern. Major plants and their parts used in Handicraft making- Socio-economic relevance.

Module 4. Botanical Photography 10 Hrs

4.1History and Basics of photography, Basic principles of different camera with an emphasis to parts, basic function, aperture and shutter speed, auto and manual focus.

4.2. Digital photography-Introduction. Factors that influence the quality of photo. Resolution and Pixel, Lens quality, Capture medium and Capture format- A comparative account on various factors.

4.3, Types of cameras used in science and research. SLR and DSLR camera. Scientific photography-Photomicrography. Digital photo editing-Photoshop. Understanding different file formats-TIFF, JPEG. Applications in research.

4.4 Aesthetics of photography. Important photographic journals.

Module 5. TEACH SPACE 15 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5Hrs

Microscopic photography and videography; Microphotography and Photomicrography

Animation tools for cartoon making

Practical 10 Hrs

1. Preparation of 5 scientific illustrations of plants
2. Preparation of 5 herbarium sheets and making one wall framed herbarium
3. Preparation of different handicrafts from plant parts (minimum 5)
4. Vegetable carving and printing – hands on experience
5. Microscopic photo taking sessions and learn basic picture taking using a digital camera
6. Photo editing using Adobe photoshop, using animation tool for plant growth description and seed germination and development
7. Leaf area determination using any mobile application soft ware

Suggested Assignment Topics- Theory

1. Botanical illustrations
2. Various formats of image storage and their characteristics
3. Photography basic aesthetics
4. Digital photo editing
5. LASER leaf printing

Suggested Assignment Topics- Practical

1. Botanical illustrations
2. Photography- Scenic and Microscopic
3. Digital photo editing
4. Science Poster making
5. Seed jewelry making

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Adams, B., (2022). Botanical illustrations: Valuable reference material for anyone interested in botany and nature.
2	Blunt, W., and Stearn W. T., (2015). The Art of Botanical Illustration: An Illustrated History.
3	Bridson Dm and L Forman. (2014). Herbarium Handbook
4	Datta S K, (2015). Dry flowers technology: Dehydration of flowers, foliages and floral craft
5	Gale L A, (2018). Botanical illustration: The complete guide. The Crowood Press Ltd;
6	Guner, I., 2019. Botanical Illustration from life, Editorial Parramon, Barcelona.
7	Gurdal Pamuklu, A., & Dursin, A., (2016). Botanical illustration techniques, Global Journal on Humanites & Social Sciences. [Online]. 03, pp 298-302. Available from: http://sproc.org/ojs/index.php/pntsbs
8	Hirsch, R.J (2017): Seizing the light: A social and Aesthetic history of photography. Routiedge.
9	http://www.ibiblio.org/unc-biology/herbarium/courses/chpt31.html
10	https://bsi.gov.in
11	https://magazines.feedspot.com/nature_photography_magaz
12	https://startupmission.kerala.gov.in/

13	https://www.kew.org/
14	https://www.pinterest.com/punkgirlabby/plant-crafts/
15	https://www.princeton.edu/~ota/disk3/1984/8430/843009.PD
16	https://www.researchgate.net/publication/355574340_Plant_image
17	https://www.startupindia.gov.in/
18	Jain, S K and RR Rao (2016). Handbook of field and herbarium methods
19	King, C., 2022. The Kew Book of Botanical illustration, Search Press.
20	Massey, J.R. (1974). Chapter 31: The Herbarium. In: Vascular Plant Systemics by A.E. Radford, W.D. Dickison, J.R. Massey & C.R. Bell). Harper & Row Publishers.
21	Pandya G., MP Ranjan and Nilam Iyer (1986). Bamboo and cane crafts of Northeast India. Development Commissioner of Handicrafts, Govt. of India, National Crafts Museum.
22	Peterson B (2009). Understanding close-up photography. Amphoto books.
23	Rix, M., 2018. The Golden Age of Botanical Art, Welbeck Publishing Group, ISBN: 9780233005423
24	Taylor D, Lowe P, Sanders P and Hallet T, (2015). Digital photography complete course, DK.
25	Thiers, B. M, (202). Herbarium: The quest to preserve and classify the worlds plants
26	Woodin C and Jess R, Botanical Art Techniques, Timber press.
27	Yadav, S.S. (2020). Herbarium: Historical account, significance, preparation techniques and management issues. *Plant archives,*20(1), page:2915–2926.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question

1. Define herbarium.
2. How do botanical illustrations differ from botanical art?
3. List any four factors influence digital photo quality.
4. Name any two major herbaria and their significance.
5. What are the key steps in herbarium specimen preparation?
6. What are the main types of herbaria?
7. What is the significance of Paleolithic cave paintings in scientific illustration?
8. What role did Herophilus play in the history of anatomical illustrations?

6 Marks Questions

1. Analyze the role of plants in interior decoration across various styles and settings.
2. Describe different types of herbaria, and cite examples.
3. Describe the primary types of scientific illustrations
4. Describe the types of cameras and digital file formats used in science and research.
5. Evaluate how does the digital herbaria enhance botanical research and education.
6. What is *Hortus Malabaricus*? Add a note on the influence of this work in modern botanical illustration?
7. Write an account on the socio-economic relevance of plant-based handicrafts in Kerala.

7 Marks Questions

1. Describe the primary types of scientific illustrations. Add a note on the differences between botanical art and botanical illustrations.
2. Describe the tools and techniques used in the process of making herbaria. Add a note on any two major herbaria in India and their significance.
3. Examine the plant-based handicraft industry in Kerala, focusing on its traditional and modern aspects.
4. Explain digital photography and factors influencing photo quality.
5. Write an account on the advantages and disadvantages of conventional herbaria over digital herbaria.
6. Describe various types of conventional and modern innovative techniques in Handicrafts.

14 Marks Questions

1. Analyze the various types of scientific illustrations and their significance in modern science.
2. Compare and contrast the different types of botanical illustrations, focusing on their characteristics and techniques.
3. Describe the conventional and modern techniques in handicraft making using plant parts.
4. Discuss the evolution of scientific illustration from Paleolithic cave paintings to the anatomical drawings of Herophilus and the botanical illustrations in the *Hortus Malabaricus*.
5. Write an account on the history and basic principles of photography.

Employability for the Course / Programme
It is one of the challenging, for both teachers and students, and innovative course which is very helpful in understanding the diverse forms of plant utilization, mixed with the aesthetics and skill of the students to achieve the heights of entrepreneurship and self-employment and thereby provides a gateway to various career paths within the realm of botany.

6	Introductory Course on Applications of Botany		KU3MDCBOT106
MDC	Semester: 3	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understanding of various terms related to applied fields of Botany.
CO2	Understanding various processes involved in applications of Botany
CO3	Application of various knowledge in applied botany in the enhancement of life skills.
CO4	Appreciation of the works of botanists and farmers in the sustenance of human population.
CO5	Development of various innovations in the studies processes.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This is a general foundation course in botany course designed for all UG students. The aim of the course is to give basic knowledge regarding various applications of botany which is relevant in all aspects of human life.

- *First module is giving an introductory idea regarding the plant life and its common uses in human life.*
- *Second module is helping the stake holder to get a knowledge on various applications of botany in agriculture.*
- *Third module deals with the applications of botany in the field of forestry.*
- *Fourth module is a module for the applications in environmental science, especially on pollution management and biofuel production.*

This course will also provide you opportunities to observe diverse applications of plants in forestry agriculture and environmental science.

Course Objectives:

1. Understanding of the fundamental applications of botany various applied fields and human life.
2. Concept development in new fields of application.

3. Enable the student to appreciate bio diversity, sustainable development with the help of their core subject and subsidiary subject botany.
4. Explore traditional and modern applications of botany.
5. Induce to experiment on the subject in an intensive way to facilitate an interdisciplinary profession/enterprise/entrepreneurship

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module1: Introduction 8Hrs

1.1 Introduction, objective and importance of applied botany. History and evolution of botany. Various disciplines of botany and their applications to human welfare
1.2 Relation of plants to man and relation with other services- Cereals, Millets, Legumes, oil seed crops, forage crops, commercial crops, plantation crops, beverages crops, spices and condiments
1.3. Basic knowledge on plant growth- Plant propagation methods. Various irrigation methods. Fertilizers and nutrients required for plant growth
1.4 Basic knowledge on plant reproduction. Flowers /inflorescences- Parts of the flower, Types of pollination and pollinators. Seed setting, collection and storage.

Module 2: Agriculture and Botany 12Hrs

2.1. Soil fertility and Plants: Biological Nitrogen Fixation Symbiotic Nitrogen Fixation in Legumes, Azolla. Green manuring and Biofertilizers. Crop rotation. Herbicides and insecticides from Plants and microbes. Microbial herbicides, bacterial insecticides, entomopathogenic fungi.
2.2. Modern agriculture practices: Scientific farming and Organic farming. Polyhouse and Precision farming, Various types of soil less cultures and hydroponics. Seed manipulation for enhancement of germination.
2.3. Branches of Horticulture: Horticulture: definition and role in human welfare. Various types and their significance. Olericulture. Pomology. Viticulture. Floriculture. Turf Management. Arboriculture.
2.4. Plant tissue culture: Definition, types- callus culture, anther culture and embryo culture. and importance. rDNA Technology for insect resistance- Bt Cotton: for quality enhancement- Golden Rice and Flavr Savr tomato.

Module 3: Forestry and Botany 5Hrs

3.1 Forestry and branches of forestry. Significance of forests. Forests and Human welfare/
3.2. Forest types in India. tropical forest, subtropical forest, temperate forest and northern coniferous forest India is a megadiversity centre. Hot spots in India.
3.3. Timber products
3.4. Non timber products from forests with plant origin- honey, resin, gums, latex,

Module 4. Environmental Science and Botany 5Hrs

4.1. Various types of pollution and their impact on plants. Plants as pollution reducers- Green belt and green corridors. Bioremediation. Phytoremediation- Phytoextraction, phytostabilization, rhizofiltration.
4.2 Carbon foot print. Carbon Sequestration and Plants. Algae for the reduction of urban

pollution- case study. Biodegradable plastics. Potent plant resources of bioplastics.
4.3. Plants as biofuels: significance, biodiesel, potent crops/algae for biofuel production, Agricultural waste management - Waste minimization, utilization of agricultural wastes- biocomposting and biogas production.
4.4. IUCN and Red Data book. Threatened and Endangered plants of India.

Module 5. TEACH SPACE 15Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5 Hrs

Various case studies on recent application of plants in environmental science, agriculture and forestry.

Practical 10 Hrs

1. Documentation of local plants with applications in human life
2. Data collection on red listed plants
3. Visit to various waste management systems
4. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Suggested Assignment Topics- Theory

1. Agroforestry
2. Botany and Agriculture
3. Botany and forestry
4. Botany and Environmental Science

Suggested Assignment Topics- Practical

1. Practicing composting for domestic purposes
2. Collection and documentation of NTFP

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Becca H, 2015. Plants Pollen and Pollinators, Collins. ISBN: 9780008163853.
2	Das K, 2025. Economic Botany. Mahaveer Publications
3	Dave R, 2022. Morphology of Flowering Plants. Lambert Academic Publishing
4	Khillar A K, 2024. History of Botany. Prashas Research Consulting Pvt Ltd.
5	Kumar N, 2021. Introduction to Horticulture. Medtech.
6	Malwa A S, 2025. Advanced Fundamentals of Agriculture (2 Vols), Narendra Publishing House
7	Manikandan K and Prabhu S, 2023. Indian Forestry. Jain Brothers.
8	Morton A G, 1981. History of Botanical Science: An Account of the Development of Botany from Ancient Times to the Present Day. Academic Press
9	Pandey B P, 1999. Economic Botany. S Chand Publications.
10	Prasad R L, 2012. Essentials of Economic Botany. Med Tech.
11	Reddy S R and Nagamani C, 2024. Introduction to Forestry. Kalyani Publishers
12	Sett R, 2012. Environmental Science a botanical and forestry perspective. Narendra Publishing House
13	Singh J, 2018. Fundamentals of Horticulture. Kalyani Publishers
14	Singh R and Singh B K, 2020.Text book on Horticulture. New India Publishing Agency, ISBN: 9789389571776.
15	Walker, T. 2020. Pollination the enduring relationship between plant and pollinator. Princeton University Press.
16	Weberling F, 1992. The Morphology of Flowers and Inflorescences, Cambridge University Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question
1. Define green corridor.
2. Differentiate flowers and inflorescences.
3. Enlist the botanical name of any two medicinal plants.
4. Explain the significance of anther culture.
5. Give an account on cereals and their significance.
6. Give any two examples for biodiesel yielding plants.
7. Name any two biodiversity hotspots in India.
8. Name any two methods of plant propagation using stem.
9. What are forage crops? Give an example.
10. What is Azolla's role in agriculture?

6 Marks Questions
1. India is a megadiversity centre. Explain with evidences.
2. Give an account on different types of non- timber forest products of Kerala.
3. Write down the basic principles of phytoremediation.
4. Give a detailed account on biodegradable plastics.
5. Write down the salient features of mangrove forests India.

7 Marks Questions
1. Explain about the types of forests in India.
2. Give an account on various strategies to manage agricultural waste.
3. What is red data book? Explain the significance.
4. Define Carbon sequestration and describe its role in modern environmental management.
5. What are the features of Flavr Savr tomato and describe its significance.

14 Marks Questions

1. Give an account on different types of forest products in India.
2. Explain in detail on the types of forests in India.
3. Use of plants in environmental pollution management is inevitable. Explain with examples.
4. Modern horticultural practices are changing spontaneously. Explain the salient features of any five modern agricultural practices.
5. Nitrogen fixation and related processes are very much significant in scientific agriculture. Explain in detail.

Employability for the Course / Programme
It is one of the basic courses which is very helpful in understanding the diverse applications of plant life. It may help students to initiate various startups and self-employment opportunities in the nera future itself.

7	Microscopy and Visualisation Tools in Biology		KU3MDCBOT107
MDC	Semester: 3	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Explain the principles and applications of light and electron microscopy in plant sciences.
CO2	Understand the fundamentals of sample preparation for light and electron microscopy.
CO3	Understand the basic parts of microscope, both light and electron microscopy.
CO4	Create a scientific enthusiasm about the morphological and anatomical variation that exist among plants.
CO5	Understand how to use visualisation tools in plant systematics, anatomy, and morphology
CO6	Be familiar with the principles of digital imaging and image analysis used in the field of Botany

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√
CO6										√	√	√

Course Description

This is a GFC course designed for all UG students for imparting the knowledge on microscopy, both theoretical and practical. The aim of the course is to give basic knowledge on this important tool of biology for the study of diverse life forms.

- *First module is a general introduction to the basic principles of microscopy.*
- *Second module delves into the world of light microscopy, giving an idea on basic principles and also on various types of light microscopy.*
- *Third module is dealing with the basic principles and procedures in electron microscopy.*
- *Fourth module is an advanced module on visualization tools and image formation principles.*

This course will also provide you opportunities to observe diverse imaging techniques in

biology,

Course Objectives:

1. Understanding of basic terms and principles of microscopy.
2. Skill in working of microscopes for different applications
3. Skill in enhancing the image contrast and clarity
4. Enthusiasm to work with electron microscope

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module1: Introduction to microscopy and visualization techniques 8 Hrs

Basic parts, principles of image formation in microscopy. Importance of direct and diffracted light in image formation. Types of microscopes and their uses. Simple microscope. Compound microscope. Electron microscope. Stereomicroscope. Scanning probe microscope. Importance and applications of microscopy in biology, Fundamentals of digital imaging and image analysis- Conversion of analog to Digital image – merits and demerits.

Module 2: Light microscopy 10 Hrs

Principles and applications, Sample preparation, Slide preparation for plant anatomy, Microscopy for plant morphology. Protocol for Light Microscopy. Types of light microscopy: Bright field, Darkfield, Phase contrast, Differential interference. Sample preparation for various light microscopy. Visualization and documentation tools used in Light microscopy. Micrometry. Various types of errors in image formation in light microscopy- Chromic aberration and Spherical aberration. Deconvolution in light microscopy.

Module 3: Electron microscopy 7 Hrs

Principles and applications, preparing samples for electron microscopy, Imaging of ultrastructure of different plant cells, Types of electron microscopy- SEM and TEM and their comparison.Merits and Demerits of Electron microscopy.

Module 4. Image analysis and visualization 5 Hrs

Fundamentals of image analysis, Image analysis techniques for plant systematics and anatomy, Visualisation tools for plant morphology and development, Crowd sourcing-based visualisation and analysis methods

Module 5. TEACH SPACE 15Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 5 Hrs

Various visualization applications available for biomedical studies

Basic principles and applications of X ray and various Scanning and imaging techniques

Practical 10 Hrs

1. Visit to labs with various imaging facilities
2. Demonstration of various microscopic techniques
3. Parts of Simple and Compound microscope

Suggested Assignment Topics- Theory

1. Light microscopy
2. Electron microscopy
3. History of microscopy
4. Principles of different microscopy
5. Applications of Microscopy

Suggested Assignment Topics- Practical

1. Demonstration of Parts of microscope
2. Documentation of different parts in various types of microscopy
3. Micrometry
4. Microscopic photography
5. Demonstration of microtomy
6. Camera lucida drawings

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Chandler, D E and Roberson, R W, 2009. Bioimaging: current concepts in LM & EM 1st Edn. Jones & Bartlett Publishers, ISBN 978-0-7637-3874-7
2	Croft W J, 2006. Under the microscope, A brief history of microscopy. World Scientific Pub Co Inc
3	Fournier, M. 1996. The fabric of life: Microscopy in the seventeenth century. Johns Hopkins University Press.
4	Fulekar M H and Pandey B, 2013. Bioinstrumentation, Tech Sar Pvt Ltd
5	Rost, F and Oldfield, R, 2000. Photography with a Microscope. Cambridge: University Press.
6	Spector, D L and Goldman, R D, 2006, Basic Methods in Light Microscopy Cold Spring Harbor Lab Press, ISBN 978-0879-69751-8
7	Thomas, C. and Woolnough, L. 2014. Understanding and using the light microscope. Milton Contact Ltd.
8	Veerakumari L, Bioinstrumentation, MJP Publishers
9	Watkins, S C and Croix, C M, 2013. Imaging and Microscopy Wiley, ISBN 978-1-118-04431-5
10	Webster J G, 2003. Bioinstrumentation, Wiley.
11	White, G. W, 1966. Introduction to microscopy. Butterworth.
12	Woolnough, L. 2010. Understanding and using the Stereomicroscope. Q.M.C

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the	10

students	

Sample Questions to test Outcomes.

2 Marks Question
1. How does a compound microscope differ from a simple microscope?
2. List out the major differences between image magnification and resolution?
3. What are the advantages of using a scanning electron microscope (SEM)?
4. What is the purpose of the diaphragm in a microscope?

6 Marks Questions
1. Explain the principle and main components of a compound microscope.
2. Give an account on light controlling techniques used in light microscopy.
3. What are the major differences between SEM and TEM
4. Write an account on the principles and components of a scanning tunneling microscope (STM)?
5. Write down the salient features and significance of stereo microscope.
6. Describe the general steps involved in preparing plant tissue samples for microscopic examination.
7. Emphasize the importance of each step in preserving cellular structures.

7 Marks Questions
1. Compare and contrast the features and application of Light microscopy and Electron microscopy.
2. Discuss the challenges faced during sample preparation for light microscopy.
3. Define chromatic aberration and spherical aberration in the context of light microscopy. Discuss their causes and methods to correct or minimize these errors.
4. Compare and contrast the two types of light microscopy: bright-field and phase contrast.
5. Evaluate the impact of different mounting media on the clarity and longevity of plant tissue slides under light microscopy.

14 Marks Questions
1. Compare and contrast simple and compound microscopes.
2. Describe the working principle of an electron microscope and its applications in biological research.
3. Discuss the importance of microscopy in biological research, including its role in cell biology and microbiology.

4. Compare and contrast the various types of light microscopy and highlight their advantages and limitations in observing plant tissues.

5. Outline the procedure for preparing microscope slides of plant tissues.

Employability for the Course / Programme

It is one of the courses that gives a foundation for the microscopic techniques through which a student can move forward through several career paths and enterpreneurships.

8	Biodiversity of Kerala and Ecotourism		KU4SECBOT108
SEC	Semester: 4	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Assess the geographic, climatic, and ecological factors contributing to Kerala's rich biodiversity
CO2	Evaluate Conservation Efforts
CO3	Identify endemic and threatened plant and animal species in Kerala
CO4	Design Sustainable Ecotourism Plans after the study of community based ecotourism projects in Kerala

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	

Course Description

This is a GFC SEC course designed for the fourth semester students of UG programmes.

- *First module is giving a basic knowledge on biodiversity of Kerala.*
- *Second module is a detailed account on flora and fauna of Kerala with case studies on endemic and invasive species*
- *Third module is giving theoretical knowledge of Ecotourism.*
- *Fourth module is directing the designing of ecotourism projects.*

This course will provide you opportunities to observe diverse forms of flora and fauna in major ecosystems of Kerala and also helps to plan ecotourism projects.

Course Objectives:

1. To explore the unique biodiversity of Kerala, emphasizing its flora, fauna, and ecosystems.
2. To understand the principles and practices of ecotourism and its role in sustainable development.
3. To analyze the interrelationship between biodiversity conservation and tourism.

4. To examine case studies of ecotourism initiatives in Kerala.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Introduction to Kerala's Biodiversity 9 hrs

1.1. Kerala’s Geography and Climate- Major ecosystems: Western Ghats, wetlands, coastal areas, and backwaters.

1.2. Kerala’s Tropical monsoon climate; Geographic and climatic factors influencing Kerala’s biodiversity.

1.3. Major Biodiversity Areas- Silent Valley National Park, Agasthyamala Biosphere Reserve, Shendurney Wildlife Sanctuary, Ashtamudi Lake and Mangrove ecosystems.

1.4. Major threats to Kerala’s biodiversity- Habitat loss and fragmentation (Case Study: Silent valley Movement) Invasive alien Species (Case study: plant-*Mikania micrantha* and animal- African snail)

Module 2: Flora and Fauna of Kerala 9 hrs

2.1. Flora- Endemic plant species, RET plants of Kerala. Medicinal plants of Kerala and their uses. Major Mangrove plants and their allies. (Case Study: *Strobilanthes kunthianus* (Neela Kurinji)

2.2. Fauna- Endemic fauna of Kerala - Nilgiri tahr, Indian elephant, lion-tailed macaque, Great hornbill (Case study: *Nasikabatrachus sahyadrensis*)

2.3. Conservation Status: red data book and IUCN. IUCN Red Listed species from Kerala.

2.4. Biodiversity Hotspots- Western Ghats as a global biodiversity hotspot; Endemic species and ecosystems. Western Ghat as World heritage site.

Module 3: Ecotourism: Concepts and Practices 9 hrs

3.1. Definition and Principles- Sustainable tourism, Community involvement and empowerment

3.2. Ecotourism Models- Community-based ecotourism; Nature reserves and wildlife sanctuaries.

3.3. Case Studies of Ecotourism: Thenmala Ecotourism and Periyar Wildlife Sanctuary, Community based – Adavi and Kadalundi

3.4. Impacts of Ecotourism- Positive impacts-Economic benefits: Employment, infrastructure development; Environmental awareness and conservation funding. Negative impacts- Environmental degradation: Pollution, habitat disturbance; Cultural impacts: Displacement, loss of traditions

Module 4: Designing Sustainable Ecotourism Models 9 hrs

4.1. Planning and Development- Site selection and feasibility studies, Infrastructure and facilities

4.2. Community Participation- Stakeholder engagement, Capacity building and training

4.3. Monitoring and Evaluation- Indicators of sustainability, Feedback mechanisms and adaptive management

4.4. Future Perspectives: Emerging trends in ecotourism; Role of technology and digital platforms in promoting sustainable tourism

Module 5. TEACH SPACE 9 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 2Hrs

Aaralam Wild life sanctuary as a place of Ecotourism; Madayippara – a biodiversity centre.

Practical 7 Hrs

1. Preparation of field visit reports by visiting any two ecotourism initiatives
2. Conduct of Photoexhibition focusing on ecotourism

3. Reels and video documentary preparation on ecotourism

Suggested Assignment Topics- Theory

1. Botanical illustrations
2. Various formats

Suggested Assignment Topics- Practical

1. Poster making
2. Seed jewelry making

Suggested Readings

Sl. No	Title/Author/Publishers of the Books and online resources
1	Biodiversity Documentation For Kerala Part 1-11, KFRI
2	K P Laladhas , Preetha N & Oommen V Oommen, Biodiversity Richness of Kerala, KSBB.
3	K.V. Sankaran, T.A.Suresh, T.V.Sajeev, Invasive Plants of Kerala, KSBB.
4	Kerala Tourism Development Corporation, *Ecotourism In Kerala: A Gateway To Nature And Sustainability*
5	N. Sasidharan, Common Trees of Kerala, KSBB.
6	P Sujanapal & N Sasidharan, Handbook On Mangroves And Mangrove Associates Of Kerala, KSBB.
7	Rajani P, A Study on Ecotourism in Kerala, Lambert Academic Publishing, ISBN-13: 978-620-6-75176-2.
8	Sustainable Development of Tourism in India: A Case Study of Kerala ISBN-13: 978-3639511284.
9	T.M. Manoharan, S.D. Biju, T.S. Nayar, and P.S. Easa, 1999. Silent Valley: Whispers of Reason
10	Vishnu S and Gayathri M S, Eco-Tourism Projects in Kerala, Thrift Books. ISBN-13: 9780993885341.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Collaborative learning-Group discussion ➢ Field Visits ➢ Documentaries	➢ Lecturing ➢ ICT ➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions

1. What are the major ecosystems found in Kerala?
2. Explain the significance of Kerala's tropical monsoon climate to its biodiversity.
3. Name two major biodiversity areas in Kerala and their importance.

4. What is the Silent Valley Movement, and why was it significant?
5. Identify two invasive species in Kerala and their impact on local ecosystems.
6. Define 'endemic species' and provide an example from Kerala.
7. What does 'RET' stand for in relation to plant species, and why is it important?
8. Mention one medicinal plant native to Kerala and its traditional use.
9. List two endemic animal species found in Kerala.
10. What is the IUCN Red List, and how does it relate to Kerala's fauna?

6 Marks Questions

1. Assess the threats posed by invasive species like Mikania micrantha and the African snail to Kerala's native ecosystems.
2. Define ecotourism and explain its core principles, emphasizing sustainable tourism and community involvement.
3. Describe the ecological importance of Kerala's backwaters and their role in supporting local biodiversity.
4. Describe the key steps involved in planning and developing a sustainable ecotourism site, including site selection and feasibility studies.
5. Describe the unique flowering cycle of Strobilanthes kunthiana (Neelakurinji) and its cultural significance in Kerala.
6. Evaluate the impact of habitat loss and fragmentation on Kerala's biodiversity, citing the Silent Valley Movement as a case study.
7. Examine the conservation status of the Nilgiri Tahr and the Lion-tailed Macaque in Kerala.
8. Examine the environmental and cultural impacts of ecotourism, highlighting both positive and negative aspects.
9. Explain how Kerala's tropical monsoon climate influences its diverse flora and fauna.
10. Explain the role of monitoring and evaluation in ensuring the sustainability of ecotourism projects, focusing on indicators and feedback mechanisms.

7 Marks Questions

1. Discuss the concept of community-based ecotourism and its significance in promoting environmental conservation.
2. Discuss the importance of community participation in ecotourism, outlining strategies for stakeholder engagement and capacity building.
3. Discuss the major ecosystems of Kerala and their significance in maintaining the state's biodiversity.
4. Discuss the significance of Kerala's mangrove ecosystems and their role in coastal biodiversity conservation.
5. Evaluate the economic benefits of ecotourism, focusing on employment generation and infrastructure development.
6. Give an account on the endemic plant species of Kerala and their ecological roles.
7. Identify emerging trends in ecotourism, particularly the use of technology and digital platforms in promoting sustainable tourism.
8. Outline the role of nature reserves and wildlife sanctuaries in ecotourism, with examples from Kerala.
9. Propose a model for a sustainable ecotourism initiative in Kerala, integrating the principles of conservation, community involvement, and economic viability.
10. Write an account on the importance of Kerala's wetlands in supporting migratory bird populations and their conservation status.

14 Marks Questions

1. Evaluate the ecological significance of Kerala's major ecosystems and discuss the factors influencing their biodiversity.
2. Discuss the role of community-based ecotourism in Kerala and assess their impact on local communities and conservation efforts.
3. Analyze the positive and negative impacts of ecotourism in Kerala. Use case studies to illustrate your points.
4. Propose a sustainable ecotourism model for a selected region in Kerala.
5. Examine the future perspectives of ecotourism in Kerala and their potential to promote sustainable tourism.

Employability for the Course / Programme

This course is a GFC SEC course that encourages the stakeholder to observe various places in Kerala on an ecological perspective and helps to develop an ecotourism plan.

9	FLORAL ART BUSINESS		KU4SECBOT109
SEC	Semester: 4	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understand the scope of floral art business and to study different styles of floral arrangement
CO2	Application of different floral arts into daily life events
CO3	Basic idea on floriculture business
CO4	Enthusiasm to earn practical skills in floral and vegetable art.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	

Course Description

This is a general foundation course SEC in botany designed for UG all students. The aim of the course is to give basic knowledge about various floral art forms and its business aspects.

- *First module is dealing with various floral art forms in this era.*
- *Second module is unravelling the diverse forms of floral arts specific to various events and its significance in daily and corporate modes of human life.*
- *Third module is helping to study the floriculture as agriculture, business and industry.*
- *Fourth module delves into the cultural heritage of India in floral arts.*

This course will also provide opportunities to go through various first hand experiences on floral arts.

Course Objectives:

1. To acquire basic knowledge on different types of floral arts, processing and packaging

2. To acquire the basics of doing floriculture business

3. To equip the students for commercial propagation for getting self-employment and for giving employment to others

4. To understand the scope of floral art business and to study different styles of floral arrangement

5. To develop practical skills in floral and vegetable art.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Floral Arts 10hrs

1.1. Flowers and inflorescences: basic parts of flowers and inflorescences, variation in longevity among different flowers, Major flowers and inflorescences used in floral art.

1.2. Floral Materials and Tools: Introduction to various flowers, foliage, and essential tools used in floral design. Popular foliage species cultivated for floral arrangement.

1.3. **Principles of Floral Design**: Balance, proportion, harmony, unity, rhythm, focal point, and scale. Understanding color schemes, textures, and composition in floral arrangements. Drying and preservation of flowers, Longevity enhancement of cut flowers

1.4. Flower arrangement types (Classical, Contemporary, European, Ikebana). Essential tools and materials used in flower arrangement.

Module 2: Types of Floral designs and arts for specific events 9 hrs

2.1. Major events in common man's life where floral art is having importance: from birth to death. Indoor and Outdoor flower arrangements.

2.2. Funeral and Sympathy Floral Designs: Designing appropriate arrangements for funerals and sympathy occasions.

2.3. Wedding and Cultural events- major parts and types of designs essential for wedding. Cultural events/ occasions that require floral art.

2.4. Holiday and Seasonal Floral Designs: Creating designs for various holidays and seasons. Floral Arrangements for Corporate clients/ exhibitions**.** Creating large-scale floral installations for events and exhibitions.

Module 3: Floriculture as agriculture, business and industry, 9 Hrs

1.1. Floriculture in India: cut flowers, loose flowers, cut foliages, potted plants,

1.2. Steps in starting floriculture business (planning, developing innovative ideas, identifying demand, marketing strategies, taking permits etc). Online and offline floral business. Kerala Start UP mission.

1.3. Value Addition: Processing flowers into products like oils, perfumes, and dried arrangements.

1.4. Sustainability Practices: Eco-friendly cultivation and certification standards

Module 4. India's Cultural Significance of Flowers 8 hrs

4.1. Types of bouquets, garland, gajra, veni and rangoli used in India.

4.2. Major flowers used in floral offerings in various temples. Flower carpet (pookkalam) of Kerala. Phool Walon Ki Sair of Delhi.

4.3. Wild flowers in floral art. Dry flower industry and vegetable carving.

4.4. Floral embroidery and Paintings in India. Chikankari of Lucknow. Phool Patti of Rampur.

Module 5. TEACH SPACE (9 hrs):

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4 hrs

Advanced Topics in Floriculture: Biotechnology Applications: Advanced Propagation Techniques: Climate Change Adaptation: Strategies for coping with environmental changes.

Practicals 5 hrs

1. Visit to floriculture industries
2. Exhibition of various types of floral decorations by the students: Dry flower preparation; Bouquets preparation; Wild flower arrangement; Vegetable carving; Preparation of garland, gajra, veni, rangoli etc.

Suggested Assignment Topics- Theory

1. Floral art
2. Features of a bouquet
3. Various floral arts
4. Flower carpet in Kerala

Suggested Assignment Topics- Practical

1. Bouquet of wild flowers
2. Flowervase arrangement
3. Exhibitions on flower arrangements

Suggested readings

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Alexander C and Taylor S (2001). Flowers cut and dried: The essential guide to growing, drying and arranging
2	Aman A S, (2016). The online startup: How to start a business online leveraging the power of Amazon.
3	Baker J L (2023). Blossoming Brilliance: A guide for mastering the art, science and creating stunning arrangements for floral symphony for your business.
4	Beener S , (2012). How to open and Operate a Financially Successful Florist and Floral Business Online and Offline.
5	Chaudhary S, (2022). The complete guide to start up: How to start a startup in India.
6	Crary C (2020). Flower School: A practical guide to the art of flower arranging.
7	Datta S K (2015). Dry flowers technology and floral craft.
8	Fasust J E and Dole J M, (2021). Cut flowers and foliages (crop production science in horticulture).
9	https://khatabook.com/blog/floriculture-business-in-india/
10	https://startupmission.kerala.gov.in/
11	https://www.startupindia.gov.in/
12	Johnson E W, (2007).The art of floral arranging.

13	Kumar H G and Kumar U M S, (2022). Economic contribution of floriculture industry in India.
14	Palma D S, Break into the wedding flower business: start a floral design business from home
15	Sahoo S K and Goswami S S, (2023). How to start a successful start-up company in India.
16	Scace P D, (2001). The floral artists guide: A reference to cult flowers and foliages.
17	Start Your Own florist shop and other floral businesses: Entrepreneur Press
18	Willms, A (2024). How to turn your passion for flowers into profit: Harvesting Happiness and Income from your floral harvests, grow, and sell your passion into profitable blooms.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits ➢ Reels on floral arts and DIY	➢ Lecturing ➢ ICT ➢ Practicals ➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. What are the basic parts of a flower?
2. Define 'inflorescence' and give an example.
3. List two major flowers used in floral art.
4. Name one tool essential for floral design.
5. What is the principle of 'balance' in floral design?
6. Explain the term 'color scheme' in floral arrangements.
7. What is Ikebana?
8. Name a seasonal floral design for festivals.
9. List any two flowers used in temple offerings.
10. What is a 'gajra'?
11. What is floriculture?
12. Define 'value addition' in floriculture.
13. What is eco-friendly cultivation?
14. Name one certification standard in floriculture.
15. What is the Kerala Startup Mission?
16. List one online platform for floral business.
17. What is 'Chikankari'?
18. Define 'Phool Patti'.
19. What is vegetable carving and name a plant part used for the art.
20. Describe a flower carpet.

6 Marks Questions:

1. Explain the basic parts of a flower and their roles in floral arrangements.
2. Discuss the importance of balance and proportion in floral design.
3. Describe the significance of color schemes and textures in creating floral compositions.
4. Compare and contrast the different types of flower arrangements: Classical, Contemporary, European, and Ikebana.
5. Elaborate on the role of floral designs in major life events such as weddings and funerals.

7 Marks Questions:
1. Analyze the cultural significance of Pookkalam in Kerala's Onam festival.
2. Discuss the considerations involved in designing floral arrangements for corporate events and exhibitions.
3. Assess the economic impact of floriculture on Kerala's economy.
4. Outline the steps involved in starting a floriculture business, including planning and marketing strategies.
5. Explore the cultural practices involving flowers in Indian rituals and festivals, focusing on their symbolic meanings.

14 Marks Questions:
1. Discuss the principles of floral design—balance, proportion, harmony, unity, rhythm, focal point, and scale—and explain how they contribute to creating aesthetically pleasing floral arrangements.
2. Analyze the cultural significance and design elements of Pookkalam, the traditional floral arrangement created during the Onam festival in Kerala.
3. Evaluate the current state and future prospects of the floriculture industry in India, focusing on its economic impact, challenges, and opportunities.
4. Examine the role of flowers in Indian cultural practices, focusing on their use in rituals, festivals, and traditional arts.
5. Investigate the intersection of floral design principles and the floriculture business, emphasizing how artistic elements influence commercial success.

Employability for the Course / Programme

It is one of the general foundation courses which is very helpful in understanding the diversity of floral arts, so as to start as an entrepreneur in floral arts.

10	ENTREPRENEURSHIP IN BOTANY	KU4SECBOT110
SEC	Semester : 4 Hrs/week : 3 Theory + 0 Practical	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Define entrepreneurship and analyze its significance in economic development
CO2	Evaluate various sources of business ideas and conduct feasibility analyses
CO3	Develop comprehensive business plans incorporating strategic objectives, financial projections, and legal considerations.
CO4	Explore opportunities in botanical entrepreneurship, including the cultivation of medicinal plants, organic farming, and sustainable agricultural practices.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4									√	√	√	√

Course Description

This is a GFC SEC course in botany designed for all UG students. The aim of the course is to give basic knowledge Botanical entrepreneurship.

- *First module is giving sparkles to the world of entrepreneurship.*
- *Second module is dealing about the business planning and strategies.*
- *Third module is delves into the vast areas of entrepreneurial botany.*
- *Fourth module deals with the future perspectives of the field. .*

This course will also provide initial induction for the botanical entrepreneurship through the field visits and other first-hand experiences.

Course Objectives:

1. To understand the foundational concepts of entrepreneurship and its role in fostering economic growth.
2. To identify and assess potential business opportunities through market analysis and feasibility studies.
3. To acquire skills to formulate effective business strategies and plans, considering

financial and legal aspects.
4. To explore innovative practices in botanical entrepreneurship, focusing on sustainable and eco-friendly ventures.
5. To develop an entrepreneurial mindset that embraces creativity, risk-taking, and problem-solving.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Entrepreneurship 8hrs

1.1. Definition and Importance: Understanding entrepreneurship and its role in economic development.
1.2. Characteristics of an Entrepreneur: Key traits and skills of successful entrepreneurs.
1.3. Types of Entrepreneurs: Based on motivation, innovation, and business scale.
1.4. Entrepreneurial Mindset: Developing creativity, risk-taking, and problem-solving abilities.

Module 2: Business Planning and Strategy 12hrs

2.1. Sources of Business Ideas: Identifying opportunities through market gaps, trends, and personal experiences.
2.2. Feasibility Analysis: Assessing technical, financial, and market feasibility. SWOT Analysis Business Model Canvas
2.3. Business Plan Components: Executive summary, market analysis, organizational structure, product/service offerings, marketing plan, and financial projections. Financial Management: Budgeting, pricing, and cost analysis.
2.4. Strategic Planning: Setting objectives, identifying resources, and formulating strategies. Legal Considerations: Business structures, intellectual property rights, and regulatory requirements.

Module 3: Major areas of Botanical Entrepreneurship 7hrs

3.1. Cultivation of Medicinal and Aromatic Plants- significance, major resource plants and economics of medicinal plants in India.
3.2. Organic Farming, Mushroom Cultivation, Plant Tissue Culture: Biofertilizers
3.3. Floriculture and Landscape Gardening; Production Agroforestry and Sustainable Agriculture:
3.4. Single Cell Protein (SCP) Secondary Metabolites Production: Fermentation Technology: Plant-Based Bioeconomy Conservation Entrepreneurship

Module 4. Contemporary Issues and Future Trends 9hrs

4.1. Understanding IPR: Patents, trademarks, and copyrights in the context of botanical products. Bioethics: Ethical considerations in plant-based research and commercialization.
4.2. Marketing Strategies: Digital marketing, retail strategies, and customer engagement. Sales Channels: Exploring online platforms, local markets, and export opportunities.
4.3. Sustainable Practices: Eco-friendly and sustainable business models. Understanding global market demands and trends in botanical products. Building connections with industry experts, mentors, and potential collaborators.
4.4. Emerging Technologies: Role of AI and IoT in modern botanical enterprises.

Module 5. TEACH SPACE 9hrs

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4 hrs

Case study: Success stories of industries on herbal medicines, mushroom cultivation, floriculture, horticulture and biofertilizer production.

Practicals 5 hrs

1. Field visits and interaction with botanical entrepreneurs.
2. Mushroom cultivation.
3. Tissue culture through callus.
4. Farm house /garden visits.
5. Vegetative propagation.

Suggested Assignment Topics- Theory

1. AI and IoT in Botanical entrepreneurships
2. Basic steps in mushroom cultivation
3. Organic farming
4. Composting
5. Biofertilisers
6. Biopesticides and insecticides
7. Tissue culture

Suggested Assignment Topics- Practical

1. Use of Mobile applications in Home gardens
2. Callus culture using coconut water
3. Budding, grafting and Layering in various crop plants.

Suggested readings

Sl. No	Title/Author/Publishers of the Book /online resources
1	https://apacwomen.ac.in/learning-resources/botany/BotanyForEntrepreneurshipDevelopment.pdf
2	https://startupmission.kerala.gov.in/
3	https://www.brainkart.com/article/Entrepreneurial-Botany_38321/#google_vignette
4	https://www.learninsta.com/entrepreneurial-botany/
5	https://www.poddarinstitute.org/articles/entrepreneurial-potential-of-economically-useful-plants
6	https://www.researchgate.net/publication/383531157_Entrepreneurial_Botany
7	https://www.startupindia.gov.in/
8	Lokare, P D and Pandya J B (2024). Entrepreneurial Botany. Book Saga Publications ISBN 13: 978-8197603839
9	Pathak, S K and Kushwah J S, Entrepreneurial Botany and Skill Development, Nitya Publications, Bhopal.
10	Paul, B.(2011). *Entrepreneurship and small business*. 3rd ed. Basingstoke, Palgrave Macmillan.
11	Sen, S, (2024). Bio-entrepreneurship: Employment, Empowerment, Innovation. Career Guidance: Choices before You, pp. 189-197, 2024 ISBN 978-81-966693-8-6, Available at SSRN: https://ssrn.com/abstract=4813601 or http://dx.doi.org/10.2139/ssrn.4813601

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments	➢ Lecturing

➢ Collaborative learning-Group discussion ➢ Documentaries and reels on agriculture, mushroom cultivation and other entrepreneurships ➢ Field visits	➢ ICT ➢ Practicals ➢ Demonstrations

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. Define entrepreneurship and explain its significance in economic development.
2. List and describe three key characteristics of a successful entrepreneur.
3. Differentiate between necessity and opportunity-based entrepreneurship.
4. What is an entrepreneurial mindset, and why is it crucial for success?
5. Identify two common sources of business ideas and explain their importance.
6. What is feasibility analysis, and why is it essential before starting a business?
7. Outline the primary components of a business plan.
8. Explain the role of strategic planning in business success.
9. Discuss the significance of legal considerations when starting a business.
10. What are medicinal and aromatic plants, and why are they economically significant in India?
11. Define organic farming and its advantages over conventional farming methods.
12. Explain the process and benefits of mushroom cultivation.
13. What is plant tissue culture, and how does it contribute to agriculture?
14. Describe the concept of floriculture and its economic impact.
15. What is agroforestry, and how does it promote sustainable agriculture?

6 Marks Questions:

1. Define entrepreneurship and discuss its significance in economic development.
2. Describe the process of strategic planning in business.
3. Differentiate between necessity and opportunity-based entrepreneurship.
4. Identify and explain three key characteristics of successful entrepreneurs.
5. Outline the key components of a business plan.

7 Marks Questions:

1. Discuss the significance of cultivating medicinal and aromatic plants in India.
2. Discuss various sources of business ideas and their significance.
3. Explain the components of a feasibility analysis.
4. Explain the concept of an entrepreneurial mindset and its importance.
5. Explain the role of biofertilizers in sustainable agriculture.

14 Marks Questions:

1. Discuss the role of entrepreneurship in economic development.
2. Explain the process of feasibility analysis in business planning, emphasizing its importance in assessing technical, financial, and market viability.

3. Analyze the economic significance of cultivating medicinal and aromatic plants in India.
4. Evaluate the impact of emerging technologies such as AI and IoT on the future of botanical entrepreneurship, considering both opportunities and challenges.
5. Assess the ethical considerations in botanical entrepreneurship, particularly concerning intellectual property rights, bioethics, and sustainable practices.

Employability for the Course / Programme
It is one of the entrepreneurship-oriented SEC courses in Botany which may benefit the stakeholder in the near future; to emerge as an entrepreneur.

11	GARDENING - INDOOR AND OUTDOOR	KU4SECBOT111
SEC	Semester : 4 Hrs/week : 3 Theory	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Demonstrate proficiency in selecting appropriate plants and gardening techniques for both indoor and outdoor environments
CO2	Apply sustainable gardening practices, including soil preparation, composting, mulching, and water conservation methods, to promote environmental sustainability
CO3	Identify and manage common pests and diseases in garden plants
CO4	Design and implement specialized gardening systems such as vertical gardens, hydroponics, and terrariums

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4									√	√	√	√

Course Description

This is GFC-SEC course in botany designed for all UG students to give basic knowledge in various types indoor and outdoor gardening. .

- *First module is giving an introduction to gardening.*
- *Second and third module is dealing with major indoor and outdoor gardening techniques respectively.*
- *Fourth module is adding some more special techniques in both out-door and in-door gardening.*

This course will provide opportunities to start gardening as a serious enterprise.

Course Objectives:

1. To understand the fundamental principles of gardening, including the importance of gardening for personal well-being and environmental sustainability.
2. To gain knowledge about various types of gardening.
3. To learn the use of essential gardening tools and equipment effectively for various gardening tasks.
4. To earn skills in plant parenting.
5. To explore advanced gardening techniques to promote sustainable practices.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Gardening 8 Hours

1.1. Definition and Importance: Understanding the role of gardening in personal well-being and environmental sustainability.

1.2. Types of Gardening: Differentiating between indoor and outdoor gardening.

1.3. Basic Terminologies: Soil, compost, mulch, irrigation, etc.

1.4. Gardening Tools and Equipment: Overview of essential tools and their uses**.**

Module 2: Module 2: Indoor Gardening Techniques 10 hours

2.1. Salient features of indoor plants, Major indoor plants and their uses for various types of indoor gardens.

2.2. Requirements for indoor gardening- Containers and Substrates: Types of pots, containers, and suitable growing media. Lighting Requirements: Natural vs. artificial lighting needs for indoor plants. Watering and Humidity: Best practices for watering and maintaining humidity levels.

2.3. Common Indoor Plants and their care and maintenance- succulents, ferns, and other in-house plants.

2.4. Indoor Plant Pests and Diseases: Identification and management of common indoor plant issues.

Module 3: Outdoor Gardening Practices 10 hours

3.1. Site Selection based on sunlight, wind, and space. Soil Preparation: Testing soil, amending soil, and composting.

3.2. Plant Selection: Choosing plants based on climate, soil, and aesthetic preferences. Planting Techniques: Proper planting depths, spacing, and timing.

3.3. Watering Systems: Drip irrigation, sprinklers, and manual watering methods. Mulching and Fertilization: Benefits and methods of mulching and fertilizing plants.

3.4. Weed and Pest Management: Organic and chemical methods for controlling weeds and pests.

Module 4. Specialized Gardening Techniques 8 hours

4.1. Vertical Gardening: Techniques for growing plants upwards using trellises, towers, and wall-mounted systems.

4.2. Hydroponics and Aquaponics: Soil-less growing methods and their applications.

4.3. Terrariums and Bottle Gardens: Creating and maintaining miniature ecosystems. Bonsai and Topiary: Art of miniature tree cultivation and shaping.

4.4. Organic Gardening: Principles and practices of organic gardening. Water Conservation: Methods to conserve water in gardening practices. Sustainable and Eco-Friendly Gardening

Module 5. TEACH SPACE 9 hrs

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4 hrs

Seasonal Planting: Understanding planting schedules for different seasons.

Climate Considerations: Gardening in various climates and microclimates.

Regional Plant Varieties: Selecting plants suited to specific regions and their growing conditions.

Garden Maintenance: Routine tasks for maintaining a healthy garden.

Practicals 5 hrs

1. Building a compost bin, creating a rainwater harvesting system, and constructing a vertical garden.
2. Plant Propagation: Techniques for propagating plants from seeds, cuttings, and divisions.

Suggested Assignment Topics- Theory

1. Lawn preparation
2. Exhibition of indoor and outdoor gardening plants
3. Bonsai preparation

Suggested Assignment Topics- Practical

1. Terrarium
2. Bonsai
3. Topiaries
4. Vertical gardening

Suggested Readings

Sl. No	Title/Author/Publishers of the Book / online resources
1	Bora T, (2021). How Not To Kill Houseplants
2	Evans C, The Gardener's Handbook
3	Fish M, (1956). We made a Garden.
4	Hawes N H, (2017). Air-Purifying Houseplant and Healthy Housekeeping. Hammersmith Health Books, ISBN: 9781781610831
5	https://archive.org/details/GardeningInIndia
6	https://celkau.in/Agrienterprises/enerprise/30.Landscape%20Gardening/4.%20COMPONENTS%20OF%20LANDSCAPES%20AND%20GARDENS.pdf
7	https://celkau.in/Agrienterprises/landscape gardening
8	https://celkau.in/Agrienterprises/Vertical farming
9	https://www.nsdcindia.org/scmp/assets/image/996525282-Gardener-PHB-English-ASCI_KM_-V1.0.pdf
10	https://www.psscive.ac.in/storage/uploads/textbooks/pdf/english/gardener-english-class-11.pdf
11	Leendertz L (2016). My Tiny Indoor Garden. Mark Diacono, London, ISBN: 9781910904992

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits ➢ Documentaries	➢ Lecturing ➢ ICT ➢ Practicals ➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5

• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. What is the role of compost in gardening?
2. Name two essential tools used for soil preparation.
3. What is the primary purpose of using containers in indoor gardening?
4. List two common pests that affect indoor plants.
5. What is the significance of mulching in outdoor gardening?
6. Define drip irrigation and its advantage over traditional watering methods.
7. What is hydroponics?
8. Name one benefit of vertical gardening.
9. What is the difference between organic and chemical fertilizers?
10. Explain the term 'sustainable gardening'.

6 Marks Questions:

1. Explain the significance of gardening in enhancing personal well-being and promoting environmental sustainability.
2. Differentiate between indoor and outdoor gardening, highlighting the unique challenges and benefits of each.
3. Define key gardening terms such as soil, compost, mulch, and irrigation, and discuss their roles in successful gardening practices.
4. Describe the process of site selection for outdoor gardening, considering factors like sunlight, wind, and space.
5. Discuss the importance of soil preparation, plant selection, and appropriate planting techniques in establishing a thriving outdoor garden.

7 Marks Questions:

1. Identify essential gardening tools and equipment, and describe their specific functions in maintaining a garden.
2. Discuss the characteristics of major indoor plants and their suitability for various types of indoor gardens.
3. Outline the requirements for indoor gardening, focusing on containers, substrates, lighting, watering, and humidity levels.
4. Provide care and maintenance guidelines for common indoor plants like succulents and ferns.
5. Identify common pests and diseases affecting indoor plants and propose effective management strategies.

14 Marks Questions:

1. Discuss the significance of indoor gardening in urban environments.
2. Explain the principles and practices involved in outdoor gardening.
3. Analyze the role of specialized gardening techniques in modern horticulture.
4. Evaluate the importance of sustainable gardening practices.
5. Assess the challenges and solutions in pest and disease management in gardening.

Employability for the Course / Programme

This SEC course is one of the self-employment oriented courses in Botany which is giving basic and advanced knowledge in outdoor and indoor gardening.

12	MEDICINAL PLANTS OF KERALA	KU4SECBOT112
SEC	Semester : 4 Hrs/week : 3 Theory	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understand the historical and cultural significance of medicinal plants in Kerala.
CO2	Identify and classify major medicinal plants of Kerala.
CO3	Analyze the pharmacological properties of medicinal plants.
CO4	Apply sustainable practices in the cultivation and conservation of medicinal plants.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2				√	√	√						
CO3							√	√	√	√		
CO4									√	√	√	

Course Description

This is a skill enhancement course in botany designed for all UG students. The aim of the course is to give basic knowledge about the diversity of medicinal plants in Kerala and its utility.

- *First module is laying the basics of plant based medicinal practices in Kerala.*
- *Second module is a pavement to the knowledge on the botanical diversity of our state.*
- *Third module delves into the pharmacological properties of chemicals present in some selected medicinal plants.*
- *Fourth module is giving an idea on the cultivation of these plants.*

This course will also provide you opportunities to emerge as an entrepreneur by knowing cultivation of medicinal plants of high commercial demand.

Course Objectives:

1. To explore the historical texts and traditional practices related to medicinal plants in Kerala.
2. To examine the botanical diversity of medicinal plants in Kerala.
3. To investigate the pharmacological properties of bioactive compounds in medicinal plants.
4. To understand the cultivation methods and sustainable practices for medicinal plants.
5. To discuss the role of institutions and government initiatives in promoting medicinal plant research and conservation.
6. To do more intensive experiments on the subject to facilitate an interdisciplinary profession/enterprise/entrepreneurship

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Medicinal practices in Kerala (10 hours) 1.1. Definition and Significance of medicinal plants: Role in traditional and modern medicine. 1.2. Overview of the use of medicinal plants in ancient texts like *Hortus Malabaricus* and *Ashtanga Hridayam*. Ayurveda and Kalari Chikilsa. 1.3. Overview of Kerala's rich plant diversity, focusing on medicinal species. Significance of endemic medicinal plants. RET Plants and conserved medicinal plants. 1.4. Scope and Relevance: Importance of medicinal plants in Kerala's cultural heritage and contemporary healthcare. Kottakkal Arya Vaidya Sala and Adivasi medicines.
Module 2: Botanical Diversity of Kerala (9 hours) 2.1. Traditional Knowledge and Ethnobotany - Folk Medicine: Exploration of traditional healing practices in Kerala. Ethnobotanical Surveys: Methodologies for documenting traditional knowledge and plant usage. 2.2. Major plant parts used as medicine- whole plant, root, bark of root and stem, stem, leaf, flower, fruit and seed. 2.3. Plant and medicinal uses – Dasapushpam, Thriphala and Dasamoolam. **2.4.** Examples for Major medicines of plant origin in Modern Medicine and Ayurveda.
Module 3: Pharmacological Properties (9 hours) 3.1. Active Compounds: Identification of bioactive compounds in medicinal plants. Examples of alkaloids, flavonoids, tannins, saponins, terpenoids, and essential oils used as therapeutic agents. 3.2. Pharmacological Activities: Antimicrobial, anti-inflammatory, antioxidant, and anticancer properties. 3.3. Major Institutes involved in Medicinal plant research and their success stories: CIMAP, Lucknow; CMPR , Kottakal, JNTBGRI, Palode. 3.4. Case Study: Arogyapacha plant (*Trichopus zeylanicus* ssp.*travancoricus*),
Module 4: Cultivation and Sustainable Practices 8hrs 4.1. Agro-techniques: Best practices for cultivating medicinal plants suited for Kerala's homesteads. 4.2. Sustainable Harvesting: Methods to ensure the sustainability of medicinal plant resources. 4.3. Conservation Efforts: Strategies for the conservation of medicinal plant species in Kerala 4.4. Government Initiatives: Overview of programs by the State Medicinal Plants Board Kerala to promote cultivation and conservation.
Module 5. TEACH SPACE (9 hrs): This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 5 hrs** Integration with Modern Medicine: Exploring how traditional medicinal plants are being integrated into contemporary healthcare systems. Phytochemical Studies: Research on the chemical constituents of medicinal plants and their therapeutic potentials. **Practicals 4 hrs**

1. Field Visits: Organized trips to botanical gardens, research stations, and local farms.
2. Hands-on Experience: Practical sessions on identifying, harvesting, and preparing medicinal plant samples.
3. Documentation Skills: Training in botanical documentation and herbarium techniques
4. Research Projects: Students undertake projects on specific medicinal plants or related topics.
5. Presentation: Presentation of findings and discussions.

Suggested Assignment Topics- Theory

1. Chemical composition of thriphala
2. Chemical properties of dasamoolam plants
3. Daspushpam and their chemistry
4. Plant parts used as medicines with examples

Suggested Assignment Topics- Practical

1. Collection of medicinal plants
2. Collection of recipes of medicined
3. Cultivation of medicinal plants

Suggested readings

Sl. No	Title/Author/Publishers of the Book / online resources
1	https://agritech.celkau.in/agriculture/medicinal
2	https://bsi.gov.in/page/en/medicinal-plant-database
3	https://envis.frlht.org/implad
4	https://www.smpbkerala.in/herbal-data/
5	https://www.kfri.res.in/medicinal_plants.asp
6	Indian Council of Agricultural Research (ICAR), Textbook of Medicinal and Aromatic Plants
7	Joshi M C, Hand Book of Indian Medicinal Plants
8	Khare C P, Indian Medicinal Plants: An Illustrated Dictionary
9	Naik V N, Identification of Common Indian Medicinal Plants
10	Peter, K.V. Alice Kurian and M. Asha Sankar, Medicinal Plants
11	Warrier, P.K., V.P.K. Nambiar, P.M. Ganapathy, Some Important Medicinal Plants of the Western Ghats, India
12	https://agritech.celkau.in/agriculture/medicinal

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions.

2 Marks Questions:

1. Name any two ancient texts on medicinal plants.
2. Who authored *Hortus Malabaricus*?
3. Name any two RET plants.
4. What is the significance of endemic medicinal plants?
5. List out any two major contributions of Kottakkal Arya Vaidya Sala.
6. Write a short note on Adivasi medicines.
7. What is ethnobotany?
8. Name a plant with medically significant bark.
9. Give the names of two plants of Dasapushpam.
10. What is Triphala?
11. Give the common name and botanical name of a plant in Dasamoolam.
12. Name a major medicine of plant origin in modern medicine.
13. What are bioactive compounds?
14. What is the major contribution of JNTBGRI in the field of ethnobotany?
15. Expand CMPR?
16. What are agro-techniques?
17. What is sustainable harvesting?

6 Marks Questions:

1. Examine the contributions of research institutes like CIMAP and JNTBGRI in advancing medicinal plant research.
2. Explain the role of traditional texts like *Ashtanga Hridayam* in preserving Ayurvedic knowledge in Kerala.
3. Integrate knowledge from all modules to propose a sustainable model for cultivating and conserving medicinal plants in Kerala.
4. Describe the ethnobotanical importance of Dasapushpam in Kerala's cultural and medicinal practices.
5. Discuss sustainable harvesting methods for medicinal plants to ensure their conservation.

7 Marks Questions:

1. Analyze the therapeutic uses of common plant parts such as roots, stems, and leaves in traditional medicine.
2. Assess the impact of government initiatives by the State Medicinal Plants Board Kerala on promoting medicinal plant cultivation.
3. Critically analyze the challenges and opportunities in integrating traditional medicinal practices with modern pharmacological research.
4. Discuss the significance of *Hortus Malabaricus* in documenting the medicinal plants of Kerala.
5. Evaluate the pharmacological activities of bioactive compounds like alkaloids and flavonoids found in medicinal plants.

14 Marks Questions:

1. Discuss their contributions to traditional medicine and their relevance in contemporary healthcare practices.
2. Explain the role of Dasapushpam in cultural practices, traditional medicine and its medicinal uses.
3. Discuss the therapeutic potentials of medicinal plants of Kerala and give examples for scientific validation of their medicinal properties.
4. Discuss the role of agro-techniques, sustainable harvesting methods, and government initiatives in promoting medicinal plant resources.

Employability for the Course / Programme

This is a GFC SEC course in botany that helps to initiate a startup in medicinal plant cultivation or medicated product preparation.

13	MUSHROOM CULTIVATION AND MARKETING	KU4SECBOT113
SEC	Semester : 4 Hrs/week : 3 Theory	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understand the scope of mushroom cultivation in economic growth of rural people.
CO2	Gaining knowledge in theoretical and practical aspects of mushroom cultivation
CO3	Basic knowledge in mushroom production and marketing.
CO4	Practical skills in cultivation, spawn production and setting up of lab for mushroom business.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	

Course Description

This is an SEC course in botany designed for all UG students with an aim to give basic knowledge in Mushroom cultivation and marketing.

- *First module is a foundation to mushroom cultivation techniques.*
- *Second module delves into the mushroom cultivation steps and processes.*
- *Third module is dealing with post harvesting processes and value addition.*
- *Fourth module is giving a basic knowledge in mushroom marketing and entrepreneurship.*

This course will provide opportunities to visit successful entrepreneurs in mushrrom cultivations and can ignite the entrepreneur mind set in the student.

Course Objectives:

1. To study theoretical and practical ideas
2. To study the crop management practices
3. To study the post -harvest management
4. To equip the students for commercial propagation for getting self employment and for giving employment to others

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1 : Introduction to Mushroom Cultivation 6 hrs

1.1. History and scope of Mushroom cultivation.

1.2. Five kingdom classification and general features of fungi. Mushroom Biology: Life cycle, morphology, and taxonomy.

1.3. Mushroom- general characters, edible and poisonous mushrooms. Nutritional and medicinal importance.

1.4. Morphology of *Agaricus bisporus* (Button), *Pleurotus* spp. (Oyster), *Volvariella volvacea* (Paddy Straw), and *Ganoderma*.

Module 2: Cultivation practices: 10 hrs

2.1. Cultivation Systems: Indoor vs. outdoor, low-cost and high-tech setups.

2.2. Spawn Production: Methods of preparation and sterilization. Substrate Preparation: Composting techniques for different substrates like paddy straw, sugarcane trash, and banana leaves.

2.3. Inoculation and Incubation: Techniques and environmental conditions. Casing and Fruiting: Role of casing materials and inducing fruiting.

2.4. Conditions for cultivation: Environmental Control: Temperature, humidity, and light management. Pest and Disease Management: Identification and control measures.

Module 3: Harvesting and Post-Harvest Handling 10 hours

3.1. Harvesting and Packaging: Optimal timing and methods of harvesting. Sorting, grading, and packaging.

3.2. Storage Methods: Refrigeration, canning, drying, and preservation in salt solutions.

3.3. Value-Added Products: Preparation of mushroom-based products like pickles, papads, and powders.

3.4. Utilization of Spent Substrate: Vermicomposting and organic farming applications.

Module 4: Mushroom Marketing and Entrepreneurship (10 hours)

4.1. Government Schemes and Support: Subsidies, training programs, and certification for Mushroom cultivation and marketing: Start up preparation, project proposal, licensing procedure and registration.

4.2. Entrepreneurial Skills: Business planning, risk management, and scaling operations.

4.3. Market Dynamics: Demand and supply analysis in local and international markets. Marketing Strategies: Branding, packaging, and labeling.

4.4. Distribution Channels: Retail, wholesale, and online platforms. Cost-Benefit Analysis: Financial planning and profitability.

Module 5. TEACH SPACE (9 hrs) This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 3 hrs

Case study: Successful stories of Mushroom Cultivation and value addition

Practicals 6 hrs

1. Spawn Preparation: Hands-on demonstration of spawn production.
2. Substrate Preparation: Composting and sterilization techniques.

3. Inoculation and Incubation: Setting up mushroom beds and monitoring environmental conditions. 4. Harvesting and Post-Harvest Handling: Practical experience in sorting, grading, and packaging. 5. Field Visit: Tour of a local mushroom farm to observe commercial operations.

Suggested Assignment Topics- Theory
1. Spawn production
2. Value added products of mushrooms
3. Canning and packing strategies
4. Toxins from mushrooms
5. Fungal taxonomy

Suggested Assignment Topics- Practical
1. Packaging of spawn
2. Composting of mushroom spent substrate
3. Collection of data on demand and supply ratio

Suggested Readings

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Ashok Agarwal, Yashpal Sharma, Esha Jangra (2022): A Text Book on Mushroom cultivation Theory and Practices
2	http://celkau.in/Agrienterprises/enerprise
3	http://celkau.in/Agrienterprises/enerprise
4	https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Mushroom_Bed%20preparation.html
5	Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K., & Jayarajan, R. (1991). *Oyster Mushrooms*. Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
6	Nita B (2000): Handbook of mushrooms. VolI and II. Oxford and IBH publishing Co. Pvt Ltd. NewDelhi
7	Pandey RK and Ghosh SK 1996: A handbook of Mushroom cultivation. Emkay publication
8	Swaminathan, M. (1990). *Food and Nutrition*. Bappco, The Bangalore Printing and Publishing Co. Ltd.
9	Tewari, P and Kapoor S C (1998): Mushroom cultivation, Mittal Publication, New Delhi

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10

•	Writing assignment	5
•	Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. What is the historical significance and current scope of mushroom cultivation?
2. Explain the Five Kingdom Classification and general features of fungi.
3. Describe the life cycle, morphology, and taxonomy of mushrooms.
4. Differentiate between edible and poisonous mushrooms, highlighting their general characteristics.
5. Discuss the nutritional and medicinal importance of mushrooms.
6. Compare the morphology of Agaricus bisporus, Pleurotus spp., Volvariella volvacea, and Ganoderma.
7. Contrast indoor and outdoor mushroom cultivation systems, including low-cost and high-tech setups.
8. Outline the methods of spawn production and sterilization techniques.
9. Explain the composting techniques for preparing substrates like paddy straw, sugarcane trash, and banana leaves.
10. Discuss the techniques for inoculation, incubation, casing, and inducing fruiting in mushroom cultivation.

6 Marks Questions:

1. Discuss the historical development and current scope of mushroom cultivation. How has it evolved from traditional practices to modern commercial production?
2. Explain the Five Kingdom Classification system with a focus on fungi. Highlight the general features that distinguish fungi from other kingdoms.
3. Explain the composting techniques for preparing substrates like paddy straw, sugarcane trash, and banana leaves. How do these substrates influence mushroom growth?
4. Discuss the inoculation and incubation processes in mushroom cultivation. What are the optimal environmental conditions for these stages?
5. Describe the role of casing materials in mushroom cultivation. How do they influence fruiting and overall yield?

7 Marks Questions:

1. Describe the life cycle and morphological characteristics of mushrooms. How do these features contribute to their growth and reproduction?
2. Differentiate between edible and poisonous mushrooms, emphasizing their general characteristics. Provide examples and discuss the importance of proper identification.
3. Analyze the nutritional and medicinal significance of mushrooms. How do their bioactive compounds contribute to health benefits?
4. Compare and contrast indoor and outdoor mushroom cultivation systems. Discuss the advantages and disadvantages of low-cost and high-tech setups.
5. Outline the methods of spawn production and sterilization techniques. Why are these steps crucial for successful mushroom cultivation?

14 Marks Questions:

1. Discuss the historical development and current scope of mushroom cultivation. How has it evolved from traditional practices to modern commercial production?
2. Compare and contrast indoor and outdoor mushroom cultivation systems. Discuss the advantages and disadvantages of low-cost and high-tech setups.
3. Explain the optimal timing and methods of harvesting mushrooms. How do sorting, grading, and packaging affect the quality and shelf life of the produce?
4. Evaluate the role of government schemes and support in promoting mushroom cultivation and marketing. How do subsidies, training programs, and certification contribute to the industry's growth?

5. Propose a comprehensive model integrating traditional knowledge, modern cultivation techniques, and sustainable practices for mushroom farming. How can this model enhance productivity and environmental responsibility?

Employability for the Course / Programme

It is one of the courses in botany which is very helpful for the student to start a life as an entrepreneur.

14	PLANT TISSUE CULTURE LAB SETUP FOR COMMERCIAL PRODUCTION	KU4SECBOT114
SEC	Semester : 4 Hrs/week : 3 Theory	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understand the scope of tissue culture as an industry
CO2	Understand the different steps in tissue culture lab setting up
CO3	Practical skills in tissue culture
CO4	Ability to do start up business in tissue culture

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	

Course Description

This SEC course is designed for all UG students to give basic knowledge about the techniques in tissue culture and its commercialization.

- *First module is introducing the fundamentals of tissue culture.*
- *Second module is related to the design and lay out of a tissue culture lab.*
- *Third module is igniting the idea of entrepreneur mindset to start a venture in tissue culture.*
- *Fourth module giving the background of certification and legal aspects of tissue culture commercialization.*

This course will provide opportunities to study all aspects in tissue culture commercialization through the setting up of a lab.

Course Objectives:

1. To equip the students for commercial propagation for starting up of enterprises on tissue culture.
2. Understand the scope of tissue culture industry.
3. To study different techniques in plant tissue culture.
4. To develop practical skills in tissue culture

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to tissue culture: 7 hrs

1.1. Overview of Plant Tissue Culture: History, principles, and applications in agriculture and horticulture.

1.2. Terms related to Tissue culture: totipotency, Differentiation, redifferentiation, Dedifferentiation, explant and callus.

1.3. Sterilization Techniques: Chemical, Heat, Autoclave, HEPA filters and Laminar Airflow. methods for sterilizing plant materials and culture media.

1.4. Basic steps in plant tissue culture: explant selection, establishment of culture, multiplication, rooting, hardening in green house and field.

Module 2: Laboratory Design and Layout of a Tissue Culture Unit 8 hrs

2.1. Infrastructure requirements for a tissue culture laboratory- Space for equipment, Incubation room with proper temperature, light and humidity; working space as wet lab.

2.2. Planning the physical space for a tissue culture lab, including clean rooms, laminar flow hoods, and sterilization areas.

2.3. Equipment and instruments necessary for tissue culture operations. Chemicals and media formulations required for culture maintenance. Importance of proper glassware and sterilization techniques.

2.4. Composition of Culture Media: Murashige and Skoog (MS) medium and its variants. Role of Plant Growth Regulators: Understanding the influence of auxins, cytokinins, and other hormones on plant development.

Module 3: Scaling Up and Commercialization of Tissue Culture 13 hours

3.1. Micropropagation Techniques: Methods for large-scale propagation of plants such as banana, orchids, and medicinal plants.

3.2. Hardening and Acclimatization: Techniques for transferring in vitro plants to ex vitro conditions.

3.3. Quality Control and Genetic Fidelity: Ensuring uniformity and disease-free status of tissue-cultured plants.

3.4. Commercial Aspects: Setting up a commercial tissue culture laboratory, including cost analysis, marketing strategies, and regulatory requirements.

Module 4. Certification procedure and starting of commercial production: 8hrs

4.1. Safety Protocols and Regulatory Compliance: Implementing safety measures and adhering to local and international regulations.

4.2. Certification procedures and regulations for commercial tissue culture production. 4.3. Steps involved in starting a tissue culture business in India (planning, developing innovative ideas, identifying demand, marketing strategies, taking permits etc.).

4.4. Funding sources and financial planning for establishing a tissue culture unit.

Module 5. TEACH SPACE (9 hrs):

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4hrs

1. Case Studies: Analysis of successful commercial tissue culture operations and lessons learned.
2. Tissue culture of medicinal plants; tissue culture for secondary metabolites.

Practicals 5 hrs

1. Media Preparation: Students will prepare MS medium and other media formulations.
2. Sterilization Techniques: Demonstrations on sterilizing plant material and culture vessels.
3. Culture Initiation: Initiating cultures from various explants.
4. Hardening Techniques: Transferring plants from in vitro to ex vitro conditions. Project
5. Work: Students will design a business plan for establishing a tissue culture laboratory, including market analysis and financial projections
6. Field visit – tissue culture lab

Suggested Assignment Topics- Theory

1. Various explants used in crops
2. Various culture media and its composition
3. Protocol for various types of tissue culture – callus, anther, etc

Suggested Assignment Topics- Practical

1. Callus development from various crop plants
2. Autoclaving demonstration

Suggested Readings

Sl. No	**Title/Author/Publishers of the Book /ONLINE resources**
1	Bajaj, Y.P.S. (1986). *Biotechnology in Agriculture and Forestry: Volume 1, High-Tech and Micropropagation I*. Springer.
2	Bajaj, Y.P.S. (1991). *Biotechnology in Agriculture and Forestry: Volume 16, Medicinal and Aromatic Plants II*. Springer.
3	Gamborg, O. L., Miller, R. A., & Ojima, K. (1968). Nutrient Requirements of Suspension Cultures of Soybean Root Cells. Experimental Cell Research, 50(1), 151-158.
4	George, E.F., Hall, M.A., & De Klerk, G.J. (2008). *Plant Propagation by Tissue Culture*. Springer.
5	Gupta, P.K. (1996). *Elements of Biotechnology*. Rastogi Publications.
6	Hammond, J., McGarvey, B., & Yusibov, V. (2000). *Plant Biotechnology: Recent Advances*. Springer.
7	Murashige, T., & Skoog, F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiologia Plantarum*, 15(3), 473-497.
8	Plant Tissue Culture Protocol Database: http://www.plantcellculture.org/
9	Prakash, J., & Rao, J. (2010). Plant Tissue Culture: Theory and Practice. Universities Press.
10	Purohit, S. S., & Mukherjee, P. K. (2003). Modern Techniques in Plant Biotechnology. I. K. International Publishing House Pvt. Ltd.
11	Rajasekaran, T., & Sathyanarayana, B. N. (2019). Plant Tissue Culture: Theory and Practice. New Age International.
12	Skoog, F., & Miller, C.O. (1957). Chemical regulation of growth and organ formation in plant tissues cultured in vitro. *Symposia of the Society for Experimental Biology*, 11, 118-130.
13	Thakur, M. (2008). Biotechnology: Microbes and Microbial Technology. Anmol Publications Pvt. Ltd.

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**

➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits ➢ Documentaries	➢ Lecturing ➢ ICT ➢ Practicals ➢ Demonstration

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. What is totipotency in plant cells?
2. Define explant in the context of tissue culture.
3. What is callus formation in plant tissue culture?
4. Explain the term 'hardening' in tissue culture.
5. What is the role of a laminar airflow hood in a tissue culture laboratory?
6. Why is sterilization crucial in tissue culture laboratories?
7. What is Murashige and Skoog (MS) medium?
8. Describe micropropagation in tissue culture.
9. What is the importance of quality control in tissue culture?
10. What are the steps involved in starting a tissue culture business in India?

6 Marks Questions:

1. Describe the sterilization techniques used in plant tissue culture laboratories, including chemical methods, heat sterilization, autoclaving, HEPA filters, and laminar airflow.
2. Outline the basic steps involved in plant tissue culture, from explant selection to hardening in the greenhouse and field.
3. Discuss the infrastructure requirements for establishing a plant tissue culture laboratory, including space for equipment, incubation rooms, and wet lab areas.
4. Discuss micropropagation techniques for large-scale propagation of crop plants
5. Define and differentiate between terms such as differentiation, dedifferentiation, redifferentiation, explant, and callus in the context of plant tissue culture

7 Marks Questions:

1. Explain the principle of totipotency in plant cells and its significance in tissue culture.
2. Explain the importance of proper laboratory design, including clean rooms, laminar flow hoods, and sterilization areas, in maintaining aseptic conditions.
3. List the essential equipment and instruments necessary for tissue culture operations and the role of proper glassware and sterilization techniques.
4. Describe the composition of Murashige and Skoog (MS) medium and its variants, and the role of plant growth regulators in influencing plant development.

5. Explain the process of hardening and acclimatization in tissue culture, and the importance of quality control and genetic fidelity in commercial production.

14 Marks Questions:

1. Discuss the historical development and principles of plant tissue culture. How have advancements in this field influenced agricultural and horticultural practices?
2. Explain the essential infrastructure requirements for establishing a plant tissue culture laboratory. How do factors like space, equipment, and environmental control contribute to successful tissue culture operations?
3. Evaluate the challenges and strategies involved in scaling up plant tissue culture for commercial production. Discuss the role of micropropagation, hardening, and quality control in this process.
4. Outline the certification procedures and regulatory requirements for establishing a commercial tissue culture production unit. How do safety protocols and compliance with regulations ensure the quality and success of the venture?

Employability for the Course / Programme
This is one of the SEC courses which is intended to help the stakeholder to initiate a startup in tissue culture and to become an entrepreneur.

15	**Basics of Anthurium and Orchid Cultivation**		**KU5SECBOT115**
SEC	**Semester: 5**	**Hrs/week: 3 Theory**	**Credits: 3**

Course Pre-requisite:

3. Completed 201-299 level
4. Ability to write examination in English

Course Outcomes	
CO1	Identify and describe the morphological, anatomical, and reproductive features of Anthurium and Orchid species.
CO2	Evaluate and manage environmental factors such as light, temperature, humidity, and soil for optimal plant performance.
CO3	Demonstrate proficiency in propagation techniques, cultivation practices, and nutrient management.
CO4	Diagnose common pest and disease problems and apply integrated pest management strategies effectively.
CO5	Analyze post-harvest processes, market dynamics, and technological innovations influencing orchid and anthurium industries

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course provides a detailed understanding of the fascinating world of Anthuriums and Orchids, two of the most valued tropical ornamental plants in global floriculture.

- *First module introduces the taxonomy, distribution, and distinguishing features of the Anthurium (Araceae) and Orchid (Orchidaceae) families and also highlights their aesthetic, medicinal, and economic importance in tropical and subtropical horticulture.*
- *Second module gives an opportunity to explore the environmental parameters necessary for healthy growth and flowering.*
- *Knowledge of propagation, watering, fertilization, pruning, and grooming techniques are imparted through the third module.*
- *Fourth module equips students with knowledge of common pests and diseases, integrated pest management (IPM), and environmentally responsible control methods and also covers*

post-harvest practices—harvest timing, grading, packaging, and export logistics
Students will explore unique botanical features, environmental adaptations, and propagation methods of orchids and anthuriums.

Course Objectives:

1. To provide foundational knowledge on the taxonomy, morphology, and anatomy of Anthurium and Orchid families.
2. To familiarize students with the environmental and cultural requirements essential for successful growth and flowering.
3. To develop technical competence in propagation, cultivation, fertilization, and maintenance practices for commercial and aesthetic production.
4. To impart skills in identifying, preventing, and managing diseases and pests affecting Anthuriums and Orchids.
5. To expose learners to post-harvest handling, market trends, and emerging technologies in floriculture and ornamental horticulture.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Introduction to Anthuriums and Orchids 12 hrs 1.1 General characteristics of Anthurium family: Distribution, Habit, habitat, Vegetative (root, Stem and Leaf) and Reproductive (inflorescence, Flower. Fruit and seed) characters. Major characters in Morphology and Anatomy. 1.2. General characteristics of Orchid family: Distribution, Habit, habitat, Vegetative (root, Stem and Leaf) and Reproductive (inflorescence, Flower. Fruit and seed) characters. Major characters in Morphology and Anatomy. 1.3. General and comparative account on anthurium and Orchids: Methods of Propagation. Adaptations to environmental conditions. Genera of Botanical, horticultural and economic importance. 1.4. Importance in Horticulture and Floriculture: Aesthetic, ecological, and commercial roles. Genera of medicinal importance.
Module 2: Environmental and Growing Requirements for orchids and anthuriums 5hrs 2.1.Light Requirements: Optimal light intensity and duration 2.2.Temperature and Humidity: Impact on growth, flowering, and dormancy 2.3.Soil and Substrate Preferences: pH, drainage, aeration, and organic matter 2.4.Potting and Container Selection: Suitable pot types, sizes, and growing media and mixtures for anthurium and orchids.
Module 3: Cultivation Practices of orchids and anthuriums 8hrs 3.1. Propagation: seed collection, storage, and germination. Vegetative propagation-cuttings, and tissue culture. Major ornamental varieties in orchids and anthuriums. 3.2. Watering: techniques, frequency, and water quality 3.3. Fertilization: nutrient types, application timing. 3.4. Pruning and grooming for shape and flower induction
Module 4. Crop Protection, Post-Harvest & Industry Trends 11 hrs 4.1. Pest and Disease Management: Identification of common pests and diseases in anthuriums and orchids. Fungal, bacterial, viral diseases and control. Integrated Pest Management (IPM) practices. 4.2. Post-Harvest Handling: General and comparative account of anthuriums and orchids-

Harvest timing, methods, and grading. Storage, packaging, and transportation techniques. 4.3. Economic Importance & Market Trends: Global and local production trends. Market value and export opportunities 4.4. Emerging technologies and challenges in cultivation and marketing. Green house and glass house cultivation. Precision and smart farming of anthuriums and orchids.
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 3Hrs** Names of various cultivars in Anthurium and Orchids. Innovative ideas – vertical gardening, hydro-aeroponic towers **Practical 6 Hrs** 1. Preparation of potting mixtures for anthurium 2. Preparation of substratum for orchid cultivation 3. Visit to ornamental farms for getting firsthand experience 4. Internship

Suggested Assignment Topics- Theory

1. Innovations in orchid and anthurium cultivation
2. Conservation of wild orchids
3. New techniques and protocols for the propagation of orchids and anthuriums
4. Methods to produce new varieties

Suggested Assignment Topics- Practical

1. Field visit
2. Acclimatisation and domestication of new varieties

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Bhattacharjee, S. K. (2006). Handbook of floriculture: Production and processing of flowers. Pointer Publishers.
2	Bhattacharjee, S. K., & De, L. C. (2010). Advanced commercial floriculture. Aavishkar Publishers.
3	Chadha, K. L., & Bhattacharjee, S. K. (Eds.). (2017). Ornamental horticulture in India (6th ed.). ICAR Publication.
4	De, L. C. (2015). Commercial orchids. Westville Publishing House.
5	De, L. C., & Bhattacharjee, S. K. (2011). Orchids: Botany, cultivation, and uses. International Book Distributing Co.
6	Kumar, N., & Arumugam, T. (2018). Ornamental horticulture. Oxford & IBH Publishing.
7	Prasad, S., & Kumar, U. (2014). Commercial floriculture. Agrobios (India).
8	Sheela, V. L. (2015). Ornamental crop breeding. Scientific Publishers (India).
9	Singh, A. K. (2017). Flower crops: Cultivation and management. New India Publishing Agency.
10	https://www.egyankosh.ac.in/bitstream/123456789/73015/1/Unit-3.pdf
11	https://diragri.assam.gov.in/sites/default/files/swf_utility_folder/departments/diragri_medhassu_in_oid_4/portlet/level_2/11%28B%29.3.pdf
12	https://agritech.tnau.ac.in/horticulture/horti_flower%20crops_anthurium.html
13	https://mindcms-main.s3.eu-west-2.amazonaws.com/dXBkYXRlLW1pbmRjbXMtbmw%3D/67b88623e2eca/794_11_24anthura-teelthandleidingsnijanthuriumbuiteneuen03lr.pdf

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Visit to well established ornamental farms	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

The emphasis given for both theoretical knowledge and practical applications, helps the student to get exposure to horticulture, floriculture enterprises, and greenhouse management and thereby the future entrepreneurship and job.

16	**Mangrove and Laterite Hill Ecology for Tourism**		KU5SECBOT116
SEC	**Semester: 5**	**Hrs/week: 3 Theory**	**Credits: 3**

Course Pre-requisite:

1. Completed 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Identify and describe the physical, chemical, and biological features of mangrove and laterite ecosystems.
CO2	Evaluate ecological processes such as nutrient cycling, species adaptations, and ecosystem services.
CO3	Assess human impacts and propose sustainable conservation and restoration strategies.
CO4	Demonstrate understanding of ecotourism principles and analyze case studies from Kerala and other Indian regions.
CO5	Apply coastal zone management concepts and adaptive strategies for ecosystem resilience and sustainable resource use.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This interdisciplinary course explores the mangrove and laterite ecosystems of India, emphasizing their ecological importance, biodiversity, and conservation.

- *First module introduces mangrove ecosystems — unique coastal wetlands known for their productivity, biodiversity, and ecological services.*
- *Second module focuses on the formation of laterite hill areas along with soil chemistry and biodiversity, with special reference to the laterite hills of northern Kerala.*
- *Third module lays foundation to the concept and evolution of ecotourism as a sustainable alternative to mass tourism.*
- *Fourth module explores integrated management approaches for conserving mangrove and laterite ecosystems though related topics of participatory restoration, adaptive management and coastal zone management (CZM and ICZM).*

By linking ecological science with sustainable ecotourism and coastal management through regional examples from Kerala students will develop practical insights into ecosystem restoration, participatory conservation, and policy frameworks that balance biodiversity conservation with

human livelihoods.

Course Objectives:

1. To introduce students to the structure, composition, and ecological significance of mangrove and laterite ecosystems in India, with emphasis on Kerala.
2. To develop understanding of the biodiversity, ecological interactions, and environmental processes unique to mangrove and laterite systems.
3. To create awareness of anthropogenic threats and conservation strategies relevant to these fragile ecosystems.
4. To familiarize learners with the principles and practices of sustainable and community-based ecotourism.
5. To enable students to integrate ecosystem management, conservation policies, and coastal zone strategies into real-world environmental planning.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Mangrove Ecosystems 1.1. Definition of mangroves. Distribution in India and Kerala. Concept of true mangroves and mangrove allies. Major mangrove plant genera in Kerala. 1.2. Physical and biological features of mangrove ecosystems. Biodiversity: plant and animal species endemic to Kerala. Migratory birds of Mangrove areas in Kerala. 1.3. Nutrient cycling and ecological interactions in mangrove ecosystems. Major plant and animal interactions in mangrove ecosystems. Role of ecosystem services and their valuation 1.4. Various environmental stressors (erosion, salinization, habitat degradation). Salient adaptations of flora and fauna to salinity, tides, and waterlogging. Human impacts: deforestation, mining, urban expansion. Traditional and modern conservation principles
Module 2: Laterite Ecosystems 2.1. Definition of laterites. Distribution in India and Kerala. Formation, structure, and composition of laterite systems. Soil characteristics and soil chemistry. Laterite-regolith geomorphology. 2.2. Chemical, Physical and biological features of laterite ecosystems., Seasonal variation in laterite hill ecology- nutrient dynamics and vegetation patterns. Role of ecosystem services and their valuation. 2.3. Ecological significance and biodiversity of laterite habitats. Key plant and animal species endemic to northern Kerala. Adaptations of flora and fauna in laterite environments. Migratory birds of laterite hill areas in Kerala. 2.4. Environmental stressors (habitat degradation, mining, erosion). Human impacts: deforestation, mining, urban expansion. Traditional and modern conservation principles
Module 3: Principles and Practice of Ecotourism 3.1. Definition and evolution of ecotourism. Principles of sustainable and responsible tourism. Importance of visitor behaviour in minimizing environmental impacts. 3.2. Community-based ecotourism models. Socioeconomic benefits and ethical considerations. Case studies from mangrove (Sundarbans, Bengal and Pichavaram, Tamilnadu) and laterite-rich regions. 3.3. Major Ecotrourism centres in Kerala. Thenmala, Gavi, Kumbalangi, Aralam 3.4. Potential mangrove and laterite ecotourism points in north Kerala- Kadalundi, Madayippara
Module 4. Ecosystem Management and Coastal Zone Strategies

4.1. Management strategies for mangrove and laterite conservation. Ecological restoration techniques and participatory conservation. Integrating ecotourism into ecosystem management 4.2. Introduction to Coastal Zone Management (CZM)- Concept of CRZ and its types. 4.3. Integrated coastal zone management approaches (ICZM). Policy frameworks, land-use planning, and stakeholder involvement 4.4. Adaptive management and resilience building in coastal systems.
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 3Hrs** Present threats to laterite hills and mangrove areas. Need of community-based management programmes. **Practical 6 Hrs** 1. Filed visits to laterite hills and mangrove areas and Panchayath offices to see the PBR 2. Preparation of biodiversity register in a selected area. 3. Survey on livelihoods of the people surrounding laterite and mangrove area 4. Survey on issues of ecosystem restoration in mangrove and laterite areas.

Suggested Assignment Topics- Theory

1. Collection of reports on laterite hill area and mangroves
2. PBR and its importance
3. Ecological, tourism and Historical importance of various mangrove and laterite hill areas such as Madayipara, Vellikkeel, Vayalapra, Pazhayangadi
4. Contributions of Kallen Pokkudan and other activists

Suggested Assignment Topics- Practical

1. Report preparation after visits
2. Documentation and inventory preparation
3. Visit to Kallen Pokkudan Memorial

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Alongi, D. M. (2009). The energetics of mangrove forests. Springer.
2	Bhaskar, D., Prejith, M. P., Rajkumar, K. P., Alex, C. J., Prasad, T. S., & Sreejith, K. A. (2017). Butterfly diversity in lateritic biotope of Kavvayi River Basin, Kerala, India. Current World Environment, 12(1), 132-141. https://doi.org/10.12944/CWE.12.1.16
3	Biju, P., Joseph Josekutty, E., Prasad, K. S., Nair Saradamma, V., & Augustine, J. (2022). Emilia lateritica (Asteraceae), a new species from lateritic plateaus of northern Kerala, India. Phytotaxa, 556(2), 201–206. https://doi.org/10.11646/phytotaxa.556.2.10
4	Blasco, F., Saenger, P., & Janodet, E. (1996). Mangroves as indicators of coastal change. Catena, 27(3–4), 167–178. Elsevier.
5	Das, M. (2011). Ecotourism: Principles, practices and policies for sustainability. Kanishka Publishers.
6	Gunnell, Y. (2000). Geomorphology and landscape evolution of the Western Ghats, India. Geological Society of India.
7	Honey, M. (2008). Ecotourism and sustainable development: Who owns paradise? (2nd ed.). Island Press.
8	Kale, V. S. (2014). Geoinformatics in applied geomorphology. CRC Press.
9	Kathiresan, K., & Bingham, B. L. (2001). Biology of mangroves and mangrove ecosystems. Advances in Marine Biology, 40, 81–251. Academic Press.
10	Kumar, K. K. (2024). Floristic structure of an abandoned quarry in Kozhikode district, Kerala, India. Indian Journal of Forestry, 47(4), 239–245. https://doi.org/10.54207/bsmps1000-2024-C6Z4YK
11	Kumar, K. K. (2024). Floristic structure of an abandoned quarry in Kozhikode district, Kerala,

	India. Indian Journal of Forestry, 47(4), 239-245. https://doi.org/10.54207/bsmps1000-2024-C6Z4YK
12	M. S. Swaminathan Research Foundation (MSSRF). (2019). Problems and 'prospects' of SEPLS conversion for alternate benefits: A research case study from the Western Ghats — Landscape of Madayippara, a laterite hill in Northern Kerala (Satoyama Development Mechanism Report). MSSRF.
13	Nayar, M. P., & Nair, N. C. (1997). Endemic plants of the Indian region. Botanical Survey of India.
14	Palot, M. J., & Radhakrishnan, C. (2005). Faunal diversity of a laterite hill system at Madayipara, Kannur District, Kerala, India (Records of the Zoological Survey of India, Occasional Papers, Vol. 242). Zoological Survey of India.
15	Pramod, C., & Pradeep, A. K. (2020). A hillock of biodiversity: Ecology and flora of Madayippara, a south Indian laterite plateau.
16	Ramesh, R., & Ramachandran, S. (2019). Coastal zone management in India: Status and future challenges. Springer.
17	Shaju, T., Rajendraprasad, M., Rijuraj, M. P., & Narayanan, M. K. R. (2017). Nanooravia kayyurense (Poaceae) – A new species from ephemeral wetlands on lateritic hillocks of north Kerala, India. International Journal of Applied Research.
18	Shaju, T., Rijuraj, M. P., Beegam, R. A., Rajendraprasad, M., & Narayanan, M. K. R. (2023). A new species of Eriocaulon L. (Eriocaulaceae) from lateritic plateaus of northern Kerala, India. Annals of Plant Sciences.
19	Shaju, T., Rijuraj, M. P., Beegam, R. A., Rajendraprasad, M., & Narayanan, M. K. R. (2023). New record of an endemic Arthraxon P. Beauv. from lateritic hillocks of northern Kerala. Journal of Plant Science and Research. (Details: published 22 July 2023)
20	Tomlinson, P. B. (2016). The botany of mangroves (2nd ed.). Cambridge University Press.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits and documentation	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

A student with a strong conceptual and field-based understanding of mangrove and laterite habitats can enter into research and job related to environmental biology and management along with some ecotourism innovations.

17	Plantation Crop Nursery Setup Management		KU5SECBOT117
SEC	Semester: 5	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Completed 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Identify the types, structure, and components of a nursery and evaluate their suitability for different plantation crops.
CO2	Design and manage nursery layouts, growing media, and plant care systems using appropriate tools and technologies.
CO3	Apply both sexual and asexual propagation techniques effectively for crops such as coconut, cashew, mango, coffee, rubber, and pepper.
CO4	Implement integrated approaches to pest, disease, and nutrient management at the nursery stage.
CO5	Develop small-scale business plans, cost estimates, and marketing strategies for commercial nursery ventures.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5										√	√	√

Course Description

This course aims to explore entrepreneurship opportunities in nursery business and marketing through the setting up of nursery of plantation crops relevant in Kerala.

- *First module provides the conceptual foundation of nursery science, emphasizing the definition, objectives, and types of nurseries.*
- *Second module focuses on the physical and biological requirements of nursery production.*
- *Third module trains students in both sexual and asexual propagation methods for seven economically important crops of Kerala.*
- *The concluding module links nursery science to business practice through the class room sessions and internships for making entrepreneurship opportunities in the plantation nursery sector..*

This course will help students to setup plantation crop nursery using scientific and managerial principles for raising healthy and profitable planting materials.

Course Objectives:

1. To provide foundational knowledge on the principles, structure, and organization of plant nurseries.

2. To develop technical competence in planning, establishing, and managing nursery infrastructure and production systems.
3. To impart skills in various propagation techniques for major plantation crops of Kerala and India.
4. To educate students on integrated pest, disease, and nutrient management in nurseries for sustainable plant production.
5. To introduce the basics of entrepreneurship, marketing, and business planning in nursery and plantation crop sectors.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Introduction to Nursery and its management 8 hrs 1.1 Basics on Nursery: Definition, importance, and scope of nurseries. Objectives and components of a nursery setup 1.2. Selection criteria for site and location: Factors-location, land topography, soil, water, drainage, transportation, labour availability, protection from animals, market needs and size etc 1.3. Nursery types: classification based on duration, plant types and structure. Duration: Temporary and permanent-advantages and disadvantages. Plant types: Ornamental, vegetable, fruit plant nursery, forest nursery. Structure: open field, Hi-tech advantages and disadvantages 1.4. Plantation nursery sector in Kerala: Rubber Board, coconut nursery of state agriculture department, PCK and other nurseries. Popular varieties in plantation crops: Coffee, rubber, coconut, arecanut, pepper, cashew and mango.
Module 2: Nursery Infrastructure and management 13 hrs 2.1. Layout and design of nursery beds: Growing media: functions, properties and types; garden soil, sand, compost, sphagnum moss, peat, coco peat, vermiculite, perlite, sawdust. Preparation of nursery beds-sunken and raised types; precautions. Soil health management and media sterilization: solarization procedure; application of formalin, fungicides, insecticides and bio-agents. Sowing of seeds and planting materials: broadcasting, line sowing, procedure, poly bags. 2.2. Plant care: shading Shade nets and polyhouses. Irrigation- manual, sprinkler, and drip. Mist chambers. Weeding. Hardening of seedlings- staking, de-shooting, pinching, pruning. Transplanting techniques. 2. 3. Fertilisers and growth regulators: Fertilization schedule and nutrient management. Plant growth regulators and its application: Commercial formulations of auxins, gibberrellins, cytokinins and ethylene, ABA etc. Applications in different plantation crops. 2.4. Disease and pest control in nursery stage: against fungi, aphids, thrips, scales, mealy bugs, mites, leaf miner and termites.
Module 3: Propagation of plantation Crops 10 hrs 3.1 Methods of propagation: **Sexual propagation**: seed selection, viability testing, and sowing**;** **Asexual propagation**: grafting, budding, layering, cutting. Seed treatment. Rootstocks and scions in commercial crops. Mother block (bud wood nursery). 3.2. Propagation of Cashew. Mango and Rubber: Selection of mother trees. Selection of seeds and seedlings. Raising seedlings through air layering, budding and softwood grafting. preparation of polybag nursery. Successful commercial methods for Cashew. Mango and Rubber. 3.3. Propagation of Coconut and Arecanut: Selection of mother plants, collection and storage of seeds. Major methods in seed bed preparation, care and management with an emphasis to successful commercial methods.

3.4. Propagation of Coffee and pepper: Coffee:Seed propagation, sowing, poly bag nursery. Pepper: propagation techniques (Bush pepper, grafting, serpentine layering, poly bag nurseries etc).
Module 4. Basics in Business and Marketing 5 hrs 4.1. Economics of nursery management: cost estimation and budgeting 4.2. Marketing strategies for nursery-raised plantation crops.Branding, packaging, and labeling of planting materials. 4.3. Record-keeping: plant inventory, input logs, sales register 4.4. Entrepreneurial opportunities in plantation crop nurseries. Government schemes, subsidies, and certifications (e.g., NHM, MIDH, NABARD).
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 3 Hrs** Successful entrepreneurs in the field. Major issues in the business. E commerce opportunity in this method. **Practical 6 Hrs** 1. Potting mixture preparation 2. Budding, Layering and grafting 3. Field visits and report preparation 4. Internship

Suggested Assignment Topics- Theory

1. Innovative methods of propagation
2. Various case studies and successful stories

Suggested Assignment Topics- Practical

1. Report preparation on successful stories in nursery enterpreneurship
2. Propagation of plantation crops

Sl. No	Title/Author/Publishers of the Book specific to the module
1	https://ncert.nic.in/vocational/pdf/kegr102.pdf
2	https://wbfbcp.org/upload/majdoc/majorupddoc241.pdf
3	https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_horti.html
4	KAU 2016: Package of practices recommendations: Crops
5	Bose, T. K., & Som, M. G. (1986). Propagation of tropical horticultural crops. Naya Prokash.
6	Bose, T. K., Kabir, J., Maity, T. K., Parthasarathy, V. A., & Som, M. G. (2001). Vegetable crops (Vol. 1–2). Naya Prokash.
7	Chadha, K. L. (2013). Handbook of horticulture (6th ed.). Indian Council of Agricultural Research (ICAR).
8	Chaturvedi, A. N., & Khanna, L. S. (2011). Forest nursery and planting techniques. Khanna Publishers.
9	Das, P., & Prasad, R. N. (2010). Propagation of horticultural crops: Principles and practices. Agrobios (India).
10	De, L. C., & Bhattacharjee, S. K. (2014). Nursery and landscape management. Westville Publishing House.
11	Devraj, A., & Rajeevan, P. K. (2018). Nursery management and plant propagation. Scientific Publishers (India).
12	Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2018). Plant propagation: Principles and practices (9th ed.). Pearson Education.
13	Kumar, N., & Arumugam, T. (2018). Introduction to horticulture. Oxford & IBH

	Publishing.
14	Pathak, M., & Singh, P. (2016). Plant nursery management: Principles and practices. Biotech Books.
15	Prasad, S., & Kumar, U. (2014). Commercial floriculture. Agrobios (India).
16	Ranjan, R., & Chaturvedi, S. N. (2017). Nursery technology for fruit crops. NIPA (New India Publishing Agency).
17	Reddy, T. Y., & Reddy, G. H. S. (2019). Principles of agronomy (6th ed.). Kalyani Publishers.
18	Sheela, V. L. (2015). Horticultural nursery management. Scientific Publishers (India).
19	Singh, A. K. (2017). Fruit crops: Cultivation and management. New India Publishing Agency.
20	Singh, H. P., & Chadha, K. L. (Eds.). (2010). Propagation and nursery management. ICAR.
21	Srivastava, R. P., & Kumar, S. (2012). Propagation of tropical fruit trees. International Book Distributing Co.
22	Thamburaj, S., & Singh, N. (2018). Vegetable, tuber, and spice crops. ICAR Publication.
23	Yawalkar, K. S. (2002). Manures and fertilizers (8th ed.). Agri-Horticultural Publishing House.
24	https://ncert.nic.in/vocational/pdf/kepc103.pdf
25	https://www.canr.msu.edu/resources/groing-media-reparation https://agritech.tnau.ac.in/agriculture/agri_pgr.html
26	http://eagri.org/eagri50/AGRO101/lec11.pdf
27	https://ncert.nic.in/vocational/pdf/kegr102.pdf

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on workshops ➢ Collaborative learning-Group discussion ➢ Field visits and demonstrations	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

Student will get orientation on how to set up nursery of plantation crops and thereby prepares students for careers in horticulture, agribusiness, and agricultural entrepreneurship.

18	Hydroponics and Aquaponics		KU5SECBOT118
SEC	Semester: 5	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Completed 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Compare and select appropriate hydroponic and aquaponic systems for specific crops and fish species.
CO2	Design and set up functional hydroponic and aquaponic systems with proper media, nutrient solutions, and environmental control.
CO3	Apply crop propagation, spacing, irrigation, and nutrient management techniques effectively in soilless cultivation.
CO4	Diagnose and manage pests, diseases, and water quality issues in hydroponics and aquaponics.
CO5	Develop business plans, record-keeping practices, and assess market opportunities for commercial soilless farming.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course provides a scientific and practical understanding of hydroponics and aquaponics systems.

- *First module is dealing with basics of hydroponics and aquaponics, their global significance, and fundamental principles.*
- *Knowledge on designing of efficient hydroponic and aquaponic systems is depicted in the second module.*
- *Third module emphasizes crop management practices specific to hydroponics and aquaponics.*
- *Fourth module covers routine system maintenance, troubleshooting, and record-keeping.*

This course will provide opportunity to integrate entrepreneurship and market opportunities, preparing students for careers in urban farming, smart agriculture, and sustainable food production.

Course Objectives:

1. To introduce the principles, types, and global significance of hydroponics and aquaponics.

2. To provide knowledge on system components, setup, and environmental requirements for soilless cultivation.
3. To develop skills in crop management, water quality monitoring, and nutrient management for hydroponic and aquaponic systems.
4. To equip students with pest and disease management strategies suitable for soilless systems.
5. To prepare learners for entrepreneurial ventures, sustainable farming practices, and commercial opportunities in hydroponics and aquaponics.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Fundamentals of Hydroponics and Aquaponics 1.1 Introduction to hydroponics and aquaponics. Global significance. Principles of hydroponic and aquaponic system. Comparison of hydroponics and aquaponics. 1.2. Components and equipment: Grow beds, tanks, pumps, aeration systems, lighting 1.3. Types: Media-based, Raft, and Coupled/Decoupled aquaponic systems. Wick, Deep Water Culture (DWC), Ebb and Flow, NFT, Aeroponics 1.4. Various plants that can be grown in hydroponics and aeroponics**.** Suitable crops and fish species for each system. Benefits and limitations of each system.
Module 2: System Design and Setup 2.1. Designing principles and Site selection, Environmental considerations 2.2.. Growing media types: cocopeat, perlite, vermiculite, clay pellets, etc 2. 3. Nutrient types and solution preparation 2.4. pH, EC, and TDS management for different crops
Module 3: Production Management and Crop Care 3.1. Plant propagation, transplanting, and spacing in soilless systems 3.2. Irrigation techniques specific to hydroponics and aquaponics. Water quality management: Monitoring water appearance, toxicity, and uptake. Water testing procedures and frequency 3.3. Nutrient management: Nutrient formulations and timing. Nutritional needs by crop type. The importance of nutrient management in hydroponic/aquaponics systems. 3.4. Integrated Pest and Disease Management (IPDM): Common pests and diseases in soilless systems. Organic and chemical control measures
Module 4: System Maintenance, Business, and Future Trends 4.1. Routine system maintenance and troubleshooting. Equipment care, repairs, and performance monitoring 4.2. Record-keeping and data tracking. 4.3. Aquaponic and hydroponic markets: Current market trends and demand. Sustainable business models and opportunities- An alternative income. game-changing technologies, and the business of sustainable living. 4.4. Entrepreneurship. Case studies on successful small-scale and commercial ventures- Urban farming, vertical farming, and smart technologies.
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 3Hrs
Major problems in Hydroponics and Aeroponics. Phytoremediation using hydroponics.
Practical 6 Hrs
1. Visit to hydroponic and aeroponic farm.
2. Documentation and record keeping
3. Internship

Suggested Assignment Topics- Theory
1. Details on successful plants that can be grown by hydroponivs/ aeroponics
2. Various types of hydroponics / aeroponics

Suggested Assignment Topics- Practical
1. Visit to innovative ideas on hydroponics and aeroponics
2. Setting up of a small hydroponic system in your home

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Delaide, B., Goddek, S., Mankasingh, U., Ragnarsdottir, K. V., Jijakli, M. H., & Thorarinsdottir, R. (2016). Challenges for sustainable aquaponics: The need for a multi-disciplinary approach. Sustainability, 8(9), 1–20.
2	Goddek, S., Joyce, A., Kotzen, B., & Burnell, G. (2015). Aquaponics food production systems: Combined aquaculture and hydroponic production technologies for the future. Springer.
3	Graber, A., & Junge, R. (2009). Aquaponic systems: Nutrient recycling from fish wastewater by vegetable production. Desalination, 246(1–3), 147–156.
4	Jensen, M. H., & Malter, A. J. (1995). Protected agriculture: A global review. World Bank Technical Paper.
5	Jones, J. B. (2016). Hydroponics: A practical guide for the soilless grower (2nd ed.). CRC Press.
6	Jones, J. B., Jr., & Olson, J. A. (2019). Hydroponics: A practical guide for commercial growers. CRC Press.
7	Lennard, W. A., & Leonard, B. V. (2006). A comparison of hydroponic and aquaponic production systems for sustainable crop and fish production. Aquaculture International, 14(5), 361–373.
8	Lennard, W. A., & Leonard, B. V. (2006). Aquaponics as a tool for urban agriculture and sustainable food systems. Urban Agriculture Magazine, 15, 16–18.
9	Liebe, T., & Goddek, S. (2018). Aquaponics engineering: Design, construction, and management of systems. Springer.
10	Nelson, P. V. (2012). Greenhouse operation and management (7th ed.). Pearson.
11	Rakocy, J. E. (2012). Aquaponics management: The science of combining aquaculture and hydroponics. Southern Regional Aquaculture Center.
12	Rakocy, J. E., Masser, M. P., & Losordo, T. M. (2006). Recirculating aquaculture tank production systems: Aquaponics–Integrating fish and plant culture. Southern Regional Aquaculture Center.
13	Resh, H. M. (2013). Hydroponic food production: A definitive guidebook for the advanced home gardener and the commercial hydroponic grower (7th ed.). CRC Press.
14	Resh, H. M. (2020). Hydroponic crop production: Science and technology. CRC Press
15	Somerville, C., & Cohen, M. (2019). Aquaponics in practice: Systems, crops, and business models. Academic Press.
16	Somerville, C., Cohen, M., & Pantanella, E. (2016). Aquaponics: Combining

	aquaculture with hydroponics. CABI.
17	Somerville, C., Cohen, M., Pantanella, E., Stankus, A., & Lovatelli, A. (2014). Small-scale aquaponic food production: Integrated fish and plant farming. FAO Fisheries and Aquaculture Technical Paper, No. 589.
18	Tyagi, S., & Kumar, A. (2018). Smart hydroponics and urban farming technologies. Springer.
19	Tyagi, S., & Kumar, S. (2017). Modern aquaponics: Principles and practices. Springer Nature.
20	Tyagi, S., & Srivastava, P. (2015). Hydroponics for beginners and commercial production. Agrobios (India).

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits and demonstrations	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

The course integrates entrepreneurship and market opportunities, preparing students for careers in urban farming, smart agriculture, and sustainable food production.

19	Plant Propagation Methods		KU5SECBOT119
SEC	Semester: 5	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Completed 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Distinguish between sexual and vegetative propagation methods and apply them to suitable crops.
CO2	Explain the mechanisms of seed development, dormancy, and germination.
CO3	Demonstrate skills in grafting, budding, layering, and micropropagation techniques.
CO4	Manage nursery infrastructure, irrigation, fertilization, and plant protection effectively.
CO5	Design small-scale propagation and nursery business models with marketing and budgeting awareness

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This introductory course elaborates the fundamental principles, techniques, and applications of plant propagation and nursery management.

- *The initial module explores the principles, importance, and objectives of plant propagation.*
- *The formation, classification, and physiology of seeds are presented in the second module.*
- *Third module covers asexual propagation techniques that ensure genetic uniformity and rapid multiplication.*
- *Fourth module is dealing with nursery setup, infrastructure design, irrigation systems, and plant care practices which is very essential in the early stages of plant propagation. .*

This course will provide opportunities to gather preliminary knowledge in theory and practice of plant propagation.

Course Objectives:

1. To introduce the basic concepts, types, and importance of plant propagation in agriculture and horticulture.

2. To develop a scientific understanding of reproductive biology and seed-based (sexual) propagation.
3. To train students in vegetative propagation techniques including grafting, budding, layering, and tissue culture.
4. To familiarize learners with nursery infrastructure, plant care, and management practices.
5. To promote entrepreneurship and economic understanding of plant propagation and nursery operations.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Introduction to Plant Propagation 1.1. Definition, Importance of plant propagation in agriculture and horticulture. Objectives and goals of plant propagation. Types- Natural and artificial. 1.2. Natural propagation from vegetative parts: Buds, Bulbs and bulbils from root, stem and leaf. Tubers, stolons, corms and rhizomes. Murraya, Bryophyllum. Orchids. 1.3. Asexual propagation from flowers and inflorescences- buds and bulbils from inflorescence and inflorescence axis-Pine apple, Agave 1.4. Overview of plant propagation systems. Sexual propagation Vs. Vegetative propagation. Relevance of propagation method in crop production.
Module 2: Sexual Propagation 2.1. Seed formation: pollination, and fertilization processes. Natural vs. artificial pollination techniques. Hybridisation. Importance of pollinators in agriculture production. Selecting appropriate pollinators for different crops. 2.2. Types of seeds- orthodox and recalcitrant, endospermous and non-endospermous, dicot and monocot seeds. Seed as a propagule – Advantages and disadvantages. Evolutionary significance. 2.3. Seed development and dormancy: Seed dormancy and reasons for seed dormancy. seed treatment for breaking seed dormancy. 2. 4. Seed germination and seedling care: germination types- hypogeal and epigeal. Conditions for successful germination. ,
Module 3: Vegetative Propagation 3.13.1.Artificial propagation by stem cuttings, leaf cuttings and root cuttings – examples of crops and ornamental plants. Factors influencing success of vegetative propagation 3.2. Budding and Grafting: Grafting: types, tools, and technique. Budding methods (T-budding, patch budding, etc.) Budding Vs. Grafting. examples from crops and ornamental plants. 3.3. Layering: Aerial, mound, serpentine, and trench layering- examples from crop and ornamental plants. 3.4. **Tissue Culture:** Concepts and scope of micropropagation. Totipotency of explants. Requirements and culture media in tissue culture. Sterilisation methods. Sterps in micropropagation. Significance of growth regulators in tissue culture. Advantages and disadvantages. Examples of crop plants and ornamentals.
Module 4: Nursery Management & Crop Production 4.1. Nursery infrastructure: Site selection and layout planning. Infrastructure and tools 4.2.. Irrigation systems and fertilization methods. Rising of seed beds, care of seedling, Post-harvest handling and seedling transplantation

transplanting techniques. 4.3. Pest and disease control. Integrated pest managements. 4.4. Planning and budgeting for propagation operations. Branding, packaging, and marketing strategies. Understanding crop cycles and supply-demand trends. Economic viability and small-scale business models
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 4 Hrs** Modern Plant Propagation Techniques: Use of bioregulators and hormone balance. Role of nutrition in plant propagation success. Precision tools and technologies in modern nurseries **Practical 5 Hrs** 1. Callus culture 2. Visit to tissue vulture lab.

Suggested Assignment Topics- Theory

1. Propagation of new exotic ornamentals.
2. Various innovations in plant propagation

Suggested Assignment Topics- Practical

1. Budding and layering
2. Grafting

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bose, T. K., & Mukherjee, D. (2005). Propagation and nursery management of plantation crops. Naya Udyog.
2	Bose, T. K., & Som, M. G. (1986). Propagation of tropical horticultural crops. Naya Prokash.
3	Chadha, K. L. (2013). Handbook of horticulture (6th ed.). ICAR.
4	Das, P., & Prasad, R. N. (2010). Propagation of horticultural crops: Principles and practices. Agrobios (India).
5	De, L. C., & Bhattacharjee, S. K. (2014). Nursery and landscape management. Westville Publishing House.
6	Devraj, A., & Rajeevan, P. K. (2018). Nursery management and plant propagation. Scientific Publishers (India).
7	George, E. F., Hall, M. A., & De Klerk, G. J. (2008). Plant propagation by tissue culture: Volume 1. The background (3rd ed.). Springer.
8	Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2018). Plant propagation: Principles and practices (9th ed.). Pearson Education.
9	Kumar, N., & Arumugam, T. (2018). Introduction to horticulture. Oxford & IBH.
10	Pathak, M., & Singh, P. (2016). Plant nursery management: Principles and practices. Biotech Books.
11	Ranjan, R., & Chaturvedi, S. N. (2017). Nursery technology for fruit crops. NIPA (New India Publishing Agency).
12	Razdan, M. K. (2003). Introduction to plant tissue culture (2nd ed.). Oxford & IBH Publishing.
13	Sheela, V. L. (2015). Horticultural nursery management. Scientific Publishers (India).
14	Singh, H. P., & Chadha, K. L. (Eds.). (2010). Propagation and nursery management. ICAR.
15	Srivastava, R. P., & Kumar, S. (2012). Propagation of tropical fruit trees. International Book Distributing Co.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

This course helps to develop both scientific understanding and entrepreneurial competence in horticultural and agricultural production.

20	Gender: A Biological Perspective		KU3VACBOT120
VAC	Semester : 3	Hrs/week : 3 Theory + 0 Practical	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understanding the biological basis of gender and various terms related to gender issues.
CO2	Appreciation of the existence of diverse human beings – LGBTQ+ instead of sexual binary.
CO3	Internalisation of political correctness on gender issues.
CO4	Modification of the individual character and behavior based on the knowledge and understanding of gender issues

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√	√	√							
CO2			√	√	√	√	√	√	√			
CO3							√	√	√	√	√	√
CO4								√	√	√	√	√

Course Description

This is a value addition course in botany, designed for UG students. The aim of the course is to give basic knowledge biological basis of sex determination and gender issues.

- *First module gives an idea about the concept of gender.*
- *Second module delves into the biological aspects of gender- the sex determination.*
- *Third module is an elaborate study on the major differences between the sexes in growth and development*
- *Fourth module is giving an opportunity to discuss various ethical aspects on gender.*

This course will provide go through various case studies of gender identity and its linkage with societal characteristics.

Course Objectives:

6. To know various gender issue related terms
7. To understand the biological basis of gender
8. To create enthusiasm to know more on diverse human behaviours and biological basis of such behaviours.
9. To develop communication skills with more political correctness

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0	3	25	50	75

			(45+ 0 + 0)	(45)			

COURSE CONTENT

Module 1: Concept of Gender 7Hrs
1.1. Definition of Gender, Sex vs. Gender, Gender Identity and expression: Social construction of gender
1.2. History of concept of Gender- Myth of binary. History of feminism, Concept of Transgender and LGBTQ+, Concept of Intersectionality.
1.3. Basis of social construction of gender- Family and Gender, Religion and gender, Education and Gender, Ecology and Gender, Science and Gender
1.4. Need, scope and significance of Gender Studies. Nature vs. nurture debate

Module 2: Biology of Sex determination 8 Hrs
2.1. Basis of Heredity-General features of Chromosomes, Genes, and DNA
2.2. Role of Chromosomes in sex determination- XX -XY mechanism, Barr body, Genic Balance theory
2.3. Role of Molecules in sex determination: Role of hormones - Estrogen, Testosterone, Progesterone
2. 4. Effects of sex hormones on the body and brain; Hormonal cycles and mood/behaviour (e.g., menstrual cycle, menopause, andropause); Hormonal influences on aggression, nurturing, and cognition

Module 3: Sexual Differentiation and Development 10Hrs
3.1. Sexual reproduction and development- Evolution of sex and mating strategies. Major variations in morphology, anatomy, and biochemistry between male and females. Variations in transgender
3.2. Embryonic development of sex organs- major stages and differences in male and female sex organ development.
3.3. Differentiation of the brain and behaviour. Mental health and gender (e.g., depression, anxiety, autism)
3.4. Role of SRY gene and androgen exposure. Intersex conditions (e.g., AIS, CAH)

Module 4. Ethical aspects of Gender 5Hrs

4.1. Misuse of biology to justify sexism or transphobia: Sex and gender based on biological essentialism. Misinterpretation of biological determinism over intersex.
4. 2. Ethical considerations in sex testing in sports: cases of Caster Semenya and Santhi Soundarajan.
4. 3. Gender verification and biomedical ethics: case of Maria José Martínez-Patiño.
4.4. Politics of biological research: Matilda effect, Neurosexism.

Module 5. TEACH SPACE (15 hrs): This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.
Theory: **5 hrs**
Case studies on gender issues – in visual media, newspapers, television, cinema and social media. Human rights and Gender rights. Various laws and organizations and/or agencies in India on gender issue.
Practicals 10Hrs

2. Collection of data /reports on various aspects of gender
3. Discussions and debates on gender issues
4. Readings on religious texts and gender issues

Suggested Assignment Topics- Theory

1. Sex and intersex
2. History of the concept of gender
3. Concept of LGBTQ+
4. Gender Vs. Science
5. Gender Vs religion
6. Local gender issues
7. Global issues of gender
8. Nature Vs Nurture

Suggested Assignment Topics- Practical

1. Discussions and debates on LGBTQ+
2. Discussions and debates on religious thoughts and gender issues

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Butler J, 2004. Undoing gender. Routledge.
2	Dick F. Swaab,2007. Sexual differentiation of the brain and behavior, Best Practice & Research Clinical Endocrinology & Metabolism, Volume 21, Issue 3,Pages 431-444, ISSN 1521-690X, https://doi.org/10.1016/j.beem.2007.04.003.
3	Furlich S, 2021. Sex Talk: How Biological Sex Influences Gender Communication Differences Throughout Life's Stages.
4	Hooks B, 1984. Feminist theory- from margin to centre. South End Press.
5	https://nios.ac.in/media/documents/340-Gender_Studies/Ch-1.pdf
6	https://ocw.mit.edu/courses/21a-231j-gender-sexuality-and-society-spring-2006/pages/lecture-notes/
7	https://transreads.org/wp-content/uploads/2022/01/2022-01-13_61e080ae9cdfc_TheSpectrumofSexTheScienceofMaleFemaleandIntersexbyHidaViloriMariaNietoz-lib.org_.pdf
8	https://web.stanford.edu/~eckert/PDF/Chap1.pdf
9	https://www.bba u.ac.in/docs/FoundationCourse/MPDC/understanding%20gender%20concepts.pdf
10	https://www.egyankosh.ac.in/bitstream/123456789/84912/1/Unit-1.pdf
11	https://www.ekvilib.org/wp-content/uploads/2017/06/01_Gender_Concepts.pdf
12	https://www.ncbi.nlm.nih.gov/books/NBK279001/
13	https://youtu.be/HLEgiR1Fsds?si=g91NljbBWO7gILsw
14	https://youtu.be/nU-rYQB_OjE
15	https://youtu.be/UD9IOllUR4k
16	Kumar N, 2022. Gender and Science -studies across Cultures, Aakar Books
17	Menon N, 2012. Seeing Like a Feminsit, Penguin Books
18	Michelle N. Arbeitman, Artyom Kopp, Mark L. Siegal, Mark Van Doren, The Genetics of Sex: Exploring Differences, *Genetics*, Volume 197, Issue 2, 1 June 2014, Pages 527–529, https://doi.org/10.1534/genetics.114.165456
19	Paulson P J, 2019. Not a Choice: What You Weren't Taught About The Biology of Sex and Gender, Handsel Pulishers Ltd.
20	Singh, L, Arya S, 2024. Feminist movements in India: Issues, Debates, Struggles, Aakar books.
21	Stryker S, 2004. Transgender History, Seal Press.

22	Watchtel S S, 1994. Molecular Genetics of Sex determination, Academic Press Inc.
23	Woolf, V. 1929. A room of one's own. Penguin books.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions

1. Define gender.
2. Differentiate between sex and gender with examples.
3. In what ways does education shape gender perceptions?
4. Name any two sex hormones in human beings with its functions.
5. What are intersex conditions? Provide two examples.
6. What is a Barr body and its significance?
7. What is biological essentialism?
8. What is intersectionality, and why is it important in gender studies?
9. What is Matilda effect,
10. What is meant by transphobia?
11. What is the SRY gene and its role in sexual differentiation?

6 Marks Questions

1. Briefly describe the connection between hormonal cycles and cognition.
2. Briefly explain the term 'neurosexism'.
3. Describe morphological differences between male and female bodies.
4. Describe the role of science in constructing gender norms.
5. Discuss gender differences in the prevalence of depression and anxiety.
6. Discuss the role of testosterone in the human body.
7. Explain gender identity and expression in the context of social construction.
8. Explain the XX-XY mechanism of sex determination.
9. How do hormones influence behavior and mood?
10. How does the family contribute to the social construction of gender?
11. How has biology been misused to justify sexism or transphobia?
12. Outline the evolutionary purpose of sexual reproduction.
13. Summarize the case of Caster Semenya in relation to gender testing.
14. Summarize the Genic Balance theory of sex determination.
15. What are the functions of estrogen and progesterone?
16. What hormonal changes occur during menopause and andropause?
17. What is the significance of the myth of binary in understanding gender?

18. Why is gender studies important in contemporary education?

7 Marks Questions

1. Briefly outline the historical development of feminism.
2. Discuss how religion influences gender roles in society.
3. Discuss the ethical issues in sex testing in sports by citing examples.
4. Give a detailed account on how sex hormones affect aggression and nurturing behaviors.
5. Give a detailed account on the stages of embryonic sex organ development.
6. How do politics intersect with scientific research on gender differences? Explain the condition by citing examples.
7. How does the brain differentiate in male and female development?
8. Why is ethical scrutiny essential in biological research on gender? Give specific examples.
9. Discuss the structural and functional relationship between DNA, genes, and chromosomes.

14 Marks Questions

1. Analyze the evolutionary origins of sexual reproduction and its impact on mating strategies across species.
2. Analyze the mechanisms of sex determination in humans, focusing on the XX-XY system, the formation of Barr bodies, and the Genic Balance Theory.
3. Critically examine the myth of the gender binary. How does this binary framework limit the understanding of gender diversity?
4. Define transgender and LGBTQ+ identities. How have societal attitudes towards these identities changed, and what challenges remain?
5. Describe the embryonic development of sex organs, highlighting the major stages and differences between male and female development.
6. Discuss gender expression and its role in societal perceptions of gender. How does it differ from gender identity, and what challenges do individuals face when their expression does not conform to societal expectations?
7. Discuss the history of feminism and its impact on the understanding of gender. What key movements have shaped feminist thought?
8. Discuss the importance of gender studies in contemporary society. What insights does this field provide into human behavior and social structures?
9. Elaborate on the concept of gender identity. How does it relate to an individual's internal sense of self, and what factors influence its development?
10. Examine the roles of estrogen, testosterone, and progesterone in sexual differentiation and reproductive health.

Employability for the Course / Programme

It is one of the challenging, for both teachers and students, general foundation course which is very helpful in understanding various aspects of gender. It adds flavors to the character and behaviors of the stakeholder through the knowledge of biology behind the gender disparities.

21	Sustainable Life Style		KU3VACBOT121
VAC	Semester: 3	Hrs/week: 3 Theory + 0 Practical	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understanding of the Core Concepts of Sustainability and the SDGs
CO2	Analyze Personal and Collective Environmental Footprints
CO3	Adopt and Promote Sustainable Practices in Energy and Water Use
CO4	Demonstrate Mindful Consumption in Food and Product Choices
CO5	Evaluate the Multidimensional Benefits of a Sustainable Lifestyle

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√	√	√							
CO2			√	√	√	√						
CO3					√	√	√					
CO4								√	√	√	√	√
CO5					√	√	√			√	√	√

Course Description

This is a general foundation course in botany/plant science designed for UG students. The aim of the course is to give basic knowledge on sustainable life style and its various reflections in daily life.

First module is an introduction to the concept of sustainability.
Second module deals with various tools and techniques of environmental footprint analysis.
Third module and forth module gives a clarity in the core area- the sustainable life style.

This course will also provide an opportunity to learn the theoretical background of sustainable life style which can be applied into various aspects of daily life.

Course Objectives:

1. To introduce the fundamental concepts of sustainability.
2. To familiarize learners with global sustainability initiatives.
3. To equip learners with the knowledge and tools to measure and analyze environmental footprints.
4. To promote the adoption of sustainable lifestyle practices.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total

3	0	3	3+ 0+ 0 (45+ 0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to concept of sustainability: 8Hrs

1.1. Definition, features and significance of sustainability in contemporary society.

1.2. Understanding the interconnection between environmental health, social equity, and economic viability.

1.3. UNESCO and SDGs. Exploration of the SDGs and their relevance to personal and community practices.

1.4. Principles of 3R's. reducing, reusing, and recycling.

Module 2: Environmental Footprint Analysis 9Hrs

2.1. Major environmental footprints- carbon, water, energy, material and waste footprints.

2.2. Methods to assess personal footprints. Steps in Conducting an Environmental Footprint Analysis

2.3. Tools and calculators for evaluating the impact of daily activities on the environment.

2.4. GHG Protocol, Life Cycle Assessment (LCA), Water Footprint Network tools, Ecological Footprint Calculator.

Module 3: Sustainable life style – Energy, water and Renewable Resources 10Hrs

3.1. Techniques for reducing energy consumption in households and communities. Use energy-efficient appliances.

3.2. Introduction to renewable energy sources such as solar, wind, and hydroelectric power. Merits and Demerits on the transition from fossil fuels to sustainable energy solutions.

3.3. Importance of water conservation in sustaining ecosystems and human populations. Understanding water scarcity issues and global disparities in water access.

3.4. Practical methods for reducing water usage in daily activities. Fix leaks, install low-flow fixtures; Rainwater harvesting- principles and types; Use water-efficient practices in gardening.

Module 4: Sustainable life style – food and other consumables 9Hrs

4.1. Impact of food production and consumption on the environment. Significance of more plant-based foods and local and organic produce.

4.2. Reducing food waste through mindful purchasing and consumption practices. Go zero-waste or low-waste

4.3. Significance of fair trade, cruelty-free, and eco-certified products. Strategies for mindful consumption, emphasizing quality over quantity. Understanding the lifecycle of products and their environmental impacts.

4.4. Benefits of sustainable life style- Environmental, Economic, Health and Social

Module 5. TEACH SPACE 9Hrs:

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 3Hrs

Role of community initiatives in promoting sustainable practices. Strategies for effective advocacy and policy influence on sustainability issues. Building networks for collective action towards sustainability goals.

Practicals 6Hrs

Sustainability Reflection Journal: Maintain a weekly journal reflecting on how sustainability connects with daily life (e.g., transport choices, food habits, etc.).

SDG Mapping Activity: Choose 2–3 Sustainable Development Goals and map how individual or community actions can contribute to each goal.

3R Audit at Home or Campus: Conduct an audit of daily waste produced and categorize it into items that can be reduced, reused, or recycled. Present findings with a suggested action plan.
Food Waste Diary: Track food waste for one week. Analyze patterns and suggest changes to reduce waste (e.g., meal planning, composting).
Zero-Waste Shopping Challenge: Visit a local market or store and attempt to make a plastic-free or zero-waste purchase. Report the experience and barriers faced.
Product Lifecycle Analysis: Choose a common product (e.g., T-shirt, mobile phone) and analyze its lifecycle—from raw material extraction to disposal. Discuss environmental impacts and alternatives.

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Bawa S K, 2011. Conservation Biology: A Primer for South Asia, Universities Press (India), ISBN: 978-8173717246
2	Belsare D K and Singh R K, 2019. Biology and Management of India's Wildlife, Himalaya Publishing House, ISBN: 978-93-5299-803-6
3	https://openknowledge.fao.org/server/api/core/bitstreams/ecb51a59-ac4d-407a-80de-c7d6c3e15fcc/content
4	https://unesdoc.unesco.org/ark:/48223/pf0000388948
5	https://www.researchgate.net/publication/313712783_Water_for_Food_-_Water_for_Life_Comprehensive_Assessment_of_Water_Management_in_Agriculture
6	Raman A, 2024. Wildlife Ecology and Conservation, Scientific Publishers, ISBN: 978-8172339746
7	Singh V, 2023. Biodiversity: Concepts, Crises, and Conservation. New India Publishing Agency, ISBN: 978-8119002351.
8	https://www.unesco.org/en/sdgs
9	Lee M B, 2022. The Carbon Footprint of Everything, Greystone Books.
10	Muthu S K, 2020. Carbon Footprints: Case Studies from the Building, Household, and Agricultural Sectors, Springer.
11	Chancel L, 2020. Unsustainable Inequalities: Social Justice and the Environment, Harvard University Press.
12	https://alison.com/course/principles-of-eco-friendly-living
13	https://www.futurelearn.com/courses/introduction-sustainability-development
14	https://www.edx.org/learn/sustainability
15	Sharma R K, Son, S and H J Ghunman, 2024. Green Consumption and Sustainable Lifestyle: Evidence from India, https://www.mdpi.com/2076-3387/14/10/262

TEACHING LEARNING STRATEGIES	**MODE OF TRANSACTION**
Hands-on experiments Collaborative learning-Group discussion	Lecturing ICT Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	**Marks**
End Semester Evaluation ESE	

• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question (Understanding)

1. Define Life Cycle Assessment (LCA).
2. Define sustainability.
3. Define water footprint and discuss its significance.
4. How can households reduce energy consumption?
5. How do the 3Rs contribute to sustainability?
6. How does UNESCO contribute to the promotion of SDGs?
7. List two features of sustainable development.
8. What is the Ecological Footprint Calculator?
9. What is the GHG Protocol?
10. Why is sustainability significant in contemporary society?

6 Marks Questions (Applying and Analyzing):

1. Define the principles of the 3Rs and their role in sustainability.
2. Describe waste footprint and its implications for the environment.
3. Explain the global disparities in water access and their implications.
4. How do energy-efficient appliances contribute to sustainability?
5. How does UNESCO contribute to the promotion of SDGs?
6. Identify and explain the key features of sustainability.
7. Provide examples of how individuals can apply the 3Rs in their daily lives.
8. What is a carbon footprint, and how can it be reduced?
9. Why is sustainability crucial in today's global context?
10. Outline methods individuals can use to assess their environmental footprints.

7 Marks Questions (Evaluating and Creating):

1. Briefly describe the environmental, economic, health, and social benefits of adopting a sustainable lifestyle.
2. Discuss the interdependence of environmental health, social equity, and economic viability in sustainable development.
3. Discuss tools available for evaluating the environmental impact of daily activities.
4. Explain how the SDGs can be integrated into personal and community practices.
5. Explain the GHG Protocol and its role in measuring greenhouse gas emissions.
6. Outline methods individuals can use to assess their environmental footprints.
7. Provide an overview of renewable energy sources such as solar, wind, and hydroelectric power
8. What is material footprint, and why is it important in sustainability?
9. What is sustainability, and how does it differ from sustainable development?
10. Write an account on the advantages and disadvantages of transitioning from fossil fuels to renewable energy solutions.

14 Marks Questions (Evaluating and Creating):

1. Describe the principles and types of rainwater harvesting systems.
Discuss the environmental, economic, health, and social benefits of adopting a sustainable lifestyle
2. Discuss tools available for evaluating the environmental impact of daily activities.
3. Evaluate the relevance of the SDGs to personal and community practices in achieving sustainability.
4. Explain techniques for reducing energy consumption in households and communities.
5. Explain the principles of the 3Rs and their importance in reducing environmental impact.
6. Give an account on practical methods for reducing water usage in daily activities.
7. Highlight a global initiative that has successfully promoted sustainability and its impact.
8. Provide examples of how individuals can apply the 3Rs in their daily lives to promote sustainability.

Employability for the Course / Programme

It is one of the foundation course that provide an environmental kinship for the stakeholders. It is very helpful in understanding the diverse actions that can be used for a sustainable lifestyle; giving an career opportunity as an environmentalist.

22	Conservation Biology		KU3VACBOT122
VAC	Semester: 3	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:
1. Knowledge in Biology at 10^{th} Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understand Core Principles of Conservation Biology
CO2	Identify Threats to Biodiversity
CO3	Evaluate Conservation Strategies and Policies
CO4	Apply Conservation Thinking to Real-world Scenarios
CO5	Develop Ethical and Sustainable Attitudes toward Nature

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2				√	√	√						
CO3						√	√					
CO4								√	√	√	√	√
CO5										√	√	√

Course Description
This is a value addition general foundation course in botany/plant science designed for all UG students in general. The basic aim of the course is to give an idea on conservation biology.
First module deals with the fundamental ideas and concepts on conservation biology. *Second module is giving an account on the basics of biodiversity concept.* *Third module is related to the theoretical background of tools and techniques used in conservation biology.* *Fourth module is giving a comprehensive account on policies, laws and actions on conservation biology.*
This course will also provide you opportunities to observe diverse aspects of conservation biology.

Course Objectives:
1. To understand the scope and ethical foundations of conservation biology
2. To examine the importance and methods of biodiversity conservation
3. To apply tools and techniques for biodiversity monitoring
4. To analyze the merits and demerits of conservation laws, policies, and global agreements in the present conditions of man-wildlife conflict.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	3 (45)	50	25	75

COURSE CONTENT

Module1: Fundamentals of conservation biology: **7Hrs**

1.1. Definition and scope of conservation biology. Ethical and philosophical foundations of conservation efforts. Branches of conservation biology.

1.2. Types of conservation strategies: In situ conservation: protected areas, habitat restoration. Ex situ conservation: zoos, botanical gardens, seed banks.

1.3. Species-specific recovery plans and Community-based conservation and sustainable use.

1.4. Major conserved areas in India and Kerala.

Module 2: Fundamentals of Biodiversity 8Hrs

2.1. Levels of biodiversity: genetic, species, and ecosystem. India as megadiversity centre. and biodiversity hotspots in India

2.2. Benefits of biodiversity. Methods for measuring biodiversity- Species Richness, Species dominance and Species abundance: Diversity Indices: Shannon-Wiener and Simpson's indices

2.3. The value of biodiversity: ecological, economic, cultural, and intrinsic. Cultural perspectives on wildlife and conservation.

2.4. Threats to biodiversity – major reasons and control measures.

Module 3. Tools and techniques used in Conservation Biology 8Hrs

3.1. Ecological survey techniques: transects, quadrats, capture- mark-recapture.

3.2. Habitat assessment and monitoring: use of GIS and remote sensing, Drones (UAVs).

3.3. Genetic and Laboratory Tools: DNA Barcoding, Environmental DNA (eDNA)

3.4. Participatory Monitoring- PBR preparation and management.

Module 4: Laws and Policies for conservation 7Hrs

4.1. National and international conservation laws and agreements.

4.2. Role of organizations like IUCN, CITES, and WWF.

4.3. Policy tools: environmental impact assessments, conservation incentives.

4.4. Human-wildlife conflict and coexistence strategies.

Module 5. TEACH SPACE (15Hrs): This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

1. Field Trips: Visits to local ecosystems, protected areas, and conservation projects.
2. Assignments: Species assessments, habitat evaluations, and policy analysis.
3. Seminars and Discussions: Debates on contemporary conservation issues and ethical considerations.
4. Documentation of the practical works – videos, microscopic photographs and other drawings by the student for evaluation as soft copy and/or hard copy.

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Bawa S K, 2011. Conservation Biology: A Primer for South Asia, Universities Press (India), ISBN: 978-8173717246
2	Belsare D K and Singh R K, 2019. Biology and Management of India's Wildlife, Himalaya Publishing House, ISBN: 978-93-5299-803-6
3	https://openknowledge.fao.org/server/api/core/bitstreams/ecb51a59-ac4d-407a-80de-c7d6c3e15fcc/content

4	Raman A, 2024. Wildlife Ecology and Conservation, Scientific Publishers, ISBN: 978-8172339746
5	Singh V, 2023. Biodiversity: Concepts, Crises, and Conservation. New India Publishing Agency, ISBN: 978-8119002351.
6	https://www.unesco.org/en/sdgs
7	Lee M B, 2022. The Carbon Footprint of Everything, Greystone Books.
8	Muthu S K, 2020. Carbon Footprints: Case Studies from the Building, Household, and Agricultural Sectors, Springer.
9	https://alison.com/course/principles-of-eco-friendly-living
10	https://www.futurelearn.com/courses/introduction-sustainability-development
11	https://www.edx.org/learn/sustainability
12	Sharma R K, Son, S and H J Ghunman, 2024. Green Consumption and Sustainable Lifestyle: Evidence from India, https://www.mdpi.com/2076-3387/14/10/262
13	Fisher M R, 2018. Environmental Biology. Open Oregon Educational Resources.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
Hands-on experiments Collaborative learning-Group discussion	Lecturing ICT Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question (Understanding)

1. Define in situ conservation, and why is it essential for biodiversity preservation?
2. Give and example for species-specific recovery plans in conservation efforts?
3. How do ethical considerations influence conservation priorities and strategies?
4. How does IUCN contribute to global conservation efforts?
5. List and briefly describe the main branches of conservation biology.
6. Name two major conserved areas in India and their significance.
7. Provide two examples for ex situ conservation.
8. What is CITES?
9. What is conservation biology, and why is it considered a multidisciplinary field?
10. What is eDNA, and how is it used in biodiversity monitoring?

6 Marks Questions (Applying and Analyzing):

1. Describe various strategies are employed to mitigate human-wildlife conflicts?
2. Explain the ecological benefits of maintaining biodiversity.
3. How does community-based conservation contribute to sustainable biodiversity management?

4. Give a brief account on the three levels of biodiversity, and why are they important?
5. What is DNA barcoding, and how does it contribute to species identification in conservation biology?

7 Marks Questions (Evaluating and Creating):
1. Describe the methods of transects and quadrats in ecological surveys. How do these techniques aid in assessing species distribution and abundance?
2. Discuss the concept of Participatory Biodiversity Registers (PBRs). How do they involve local communities in conservation efforts?
3. Explain how Geographic Information Systems (GIS) and remote sensing technologies are utilized in habitat assessment and monitoring.
4. What is the role of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in global conservation efforts?

14 Marks Questions (Evaluating and Creating):
1. Analyze the ecological, economic, cultural, and intrinsic values of biodiversity. How do cultural perspectives influence wildlife conservation?
2. Assess the effectiveness of current conservation laws and policies in India. What improvements can be made to enhance biodiversity protection?
3. Compare and contrast in situ and ex situ conservation strategies. Provide examples of each and discuss their advantages and limitations.
4. Define DNA barcoding and environmental DNA (eDNA). How do these genetic tools assist in species identification and biodiversity monitoring?
5. Describe various methods for measuring biodiversity. Discuss their applications and limitations.
6. Evaluate the advantages and challenges of using Geographic Information Systems (GIS) and remote sensing in habitat assessment and monitoring.
7. Explain methods for measuring biodiversity, focusing on species richness, dominance, and abundance. How do diversity indices like Shannon-Wiener and Simpson's indices aid in this assessment?
8. Explain the concept of species-specific recovery plans. How do community-based conservation and sustainable use contribute to biodiversity preservation?
9. Identify and describe major conserved areas in India and Kerala. Discuss their significance in the context of national and global conservation efforts.
10. What are biodiversity hotspots? Identify and explain the significance of biodiversity hotspots in India.

Employability for the Course / Programme

This foundation course will provide an opportunity to delve into the field of conservation biologist.

23	BASICS OF ENVIRONMENTAL SCIENCE	KU4VACBOT123
VAC	Semester : 4 Hrs/week : 3 Theory + 0 Practical	Credits: 3

Course Pre-requisite:

3. Knowledge in Biology at 10th Standard
4. Ability to write examination in English

Course Outcomes	
CO1	Describe Ecosystem Structure and Function
CO2	Assess Biodiversity and Its Importance
CO3	Evaluate Health Impacts of Pollution
CO4	Apply Critical Thinking to Environmental Issues
CO5	Communicate Environmental Concepts Effectively

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This is a general foundation course in botany for all UG students. The aim of the course is to give basic knowledge about the environmental science.

- *First module gives an idea on the basics of ecology.*
- *Second module is dealing with an idea on the ecosystems and biodiversity.*
- *Third module describes the basics of environmental pollution and its impacts.*
- *Fourth module develops the concept of sustainable development.*

This course will also provide you opportunities to observe diverse ecosystems and impacts of pollution in global environment.

Course Objectives:

1. To understand the interdisciplinary nature of Environmental Science.
2. To analyze ecosystem dynamics and biodiversity in the surroundings.
3. To assess the width and depth of environmental issues and also to internalize sustainable practices
4. To develop critical thinking and thereby enhancing the skill of problem solving in the era of climate change.

Credit	Teaching Hours	Assessment

L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Environmental Science (8 hours)

1.1. Definition and Scope: Understanding environmental science as an interdisciplinary field.

1.2. Multidisciplinary Nature: Integration of biology, chemistry, physics, geography, and social sciences.

1.3. Importance of Environmental Science: Role in addressing environmental challenges.

1.4. Concepts of Sustainability and Sustainable Development: Principles and practices for sustainable living.

Module 2: Ecosystems and Biodiversity (10 hours)

4.1. Ecosystem Structure and Function: Components and energy flow. Biogeocehmical cycles.

4.2. Types of Ecosystems: Forest, grassland, desert, and aquatic ecosystems.

4.3. Biodiversity: Definition, importance, and levels (genetic, species, ecosystem). Threats to Biodiversity: Habitat loss, poaching, invasive species.

4.4. Conservation of Biodiversity: In-situ and ex-situ conservation methods.

Module 3: Environmental Pollution and Health (9 hours)

3.1. Types of Pollution: Air, water, soil, noise, and thermal pollution.

3.2. Sources and Effects: Industrial, agricultural, and domestic sources.

3.3. Health Impacts: Diseases related to environmental pollution.

3.4. Control Measures: Technological and policy interventions.

Module 4: Environmental Issues and Sustainable Practices 9 hours

4.1. Climate Change: Causes, impacts, and mitigation strategies.

4.2. Deforestation and Desertification: Consequences and preventive measures.

4.3. Water Resources Management: Conservation and sustainable usage.

4.4. Waste Management: Solid waste, recycling, and composting.

Module 5: TEACH SPACE 9 hrs

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4 Hrs

Sustainable Agriculture and Energy: Practices for sustainable development.

Environmental Policies and Legislation: National and international frameworks. Biodiversity hot spots. Case study: Pollution sites and its reclamation. Brahmapuram of Ernakulam.

Practical Component (5 hours)

Field Visit: Visit to a local ecosystem (e.g., forest, wetland) to observe biodiversity and ecosystem functions.

Pollution Assessment: Collecting and analyzing water or soil samples for pollution indicators.

Waste Audit: Conducting a waste audit in the campus or community to understand waste generation patterns.

Sustainable Practices Workshop: Demonstration of composting, rainwater harvesting, and energy conservation techniques.

Suggested Assignment Topics- Theory

1. Ecosystem

2. Environmental Pollution
3. Climate Change
4. Waste management
5. Biodiversity hotspots

Suggested Assignment Topics- Practical

1. Case studies on Biodiversity hotspots
2. Waste audit
3. Sustainable development Goals and Daily life

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Baird, C., & Cann, M. (2012). *Environmental Chemistry*.
2	Gupta, P.K. (1996). *Elements of Environmental Science and Engineering*.
3	Kormondy, E.J. (2013). *Concepts of Ecology*.
4	Meadows, D.H., Meadows, D.L., & Randers, J. (2004). *Limits to Growth: The 30-Year Update*.
5	Miller, G.T. (2013). *Living in the Environment: Principles, Connections, and Solutions*.
6	Odum, E.P. (2004). *Fundamentals of Ecology*.
7	Primack, R.B. (2014). *Essentials of Conservation Biology*.
8	Stern, P.C., & Fineberg, H.V. (1996). *Understanding Risk: Informing Decisions in a Democratic Society*.
9	Koparde A A, Patil A A and Doijad R C, (2020). A Textbook of Basic Concepts in Environmental Science. Akinik Publications.
10	Thakur, V. (2019). A text book of Environmental Science. Sciencetific Publishers.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits	➢ Lecturing ➢ ICT ➢ Practicals ➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question

1. What is the scope of environmental science?
2. Name any two interdisciplinary fields integrated into environmental science.
3. Explain the concept of sustainability.
4. What is sustainable development?
5. List the three levels of biodiversity.

6. Mention any two threats to biodiversity.
7. Name any two types of pollution.
8. What are biodegradable pollutants?
9. List any two causes of deforestation.
10. What is desertification?
11. Explain recycling.
12. What is composting?

6 Marks Questions:

1. Explain the interdisciplinary nature of environmental science and its significance in addressing environmental issues.
2. Discuss the concept of sustainability and its importance in promoting sustainable development practices.
3. Analyze the relationship between environmental pollution and public health, emphasizing the role of policy interventions.
4. Examine the causes and consequences of climate change, and propose strategies for its mitigation.
5. Discuss the importance of waste management and recycling in promoting sustainable living practices.

7 Marks Questions:

1. Describe the structure and function of an ecosystem, highlighting the roles of producers, consumers, and decomposers.
2. Define biodiversity and explain its significance in maintaining ecological balance and supporting ecosystem services.
3. Identify the major threats to biodiversity and discuss strategies for its conservation.
4. Explain the different types of environmental pollution and their impact on human health and the environment.
5. Discuss the sources and effects of water pollution, and suggest measures to prevent and control it.

14 Marks questions

1. Discuss the interdisciplinary nature of environmental science and its significance in addressing contemporary environmental challenges.
2. Explain the structure and function of ecosystems, highlighting the role of organisms in different trophic levels. Add a short note on the importance of biodiversity in maintaining ecosystem stability.
3. Analyze the various types of environmental pollution, their sources, and their impacts on human health and the environment. Propose effective control measures for each type of pollution.
4. Examine the causes and consequences of climate change. Discuss global and local mitigation strategies.
5. Evaluate the role of government policies and individual actions in promoting environmental conservation. Does legislation is effective in achieving environmental sustainability?

Employability for the Course / Programme
It is one of the VAC courses in botany which is very helpful in understanding the basics of environmental science; directing to the passionate world of environmentalist.

24	CLIMATE CHANGE AND DISASTER MANAGEMENT	KU4VACBOT124
VAC	Semester : 4 Hrs/week : 3 Theory + 0 Practical	Credits : 3

Course Pre-requisite:

1. Knowledge in Biology at 10^{th} Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Understand the fundamental concepts of climate and weather
CO2	Analyze the effect of Global Warming in various natural disasters and climate change
CO3	Analyze the effects of climate change on ecosystems and human systems
CO4	Explore Mitigation Strategies and Policy Frameworks

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	

Course Description

This is a GFC VAC course in botany designed for all UG students.The aim of the course is to give basic knowledge about the climate change and disaster managements.

- *First module is unraveling the basic concepts on climate change.*
- *Second module is giving an idea on disasters and their management strategies.*
- *Third module delves into the impacts of climate change.*
- *Fourth module tells about various national and international mitigation strategies and agreements.*

This course will also provide you opportunities to observe the impacts of climate change.

Course Objectives:

1. To know about Earth's climate systems and its variability.
2. To understand the concept greenhouse effect and global warming
3. To assess the role of disaster management in reducing the impact on human life.
4. To analyze the impacts of climate change on biosphere.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Climate Change (8 hours)

1.1. Climate and Weather. Climate Systems and Variability: Understanding Earth's climate systems and natural variability. Concept of microclimates.

1.2. Greenhouse Effect and Global Warming: Mechanisms and implications.

1.3. Anthropogenic activities leading to Global warming. Other causes of Global warming.

1.4. Direct and indirect impacts of global warming: Rising temperatures, sea-level rise, and extreme weather events. future projections.

Module 2: Disasters and Their Management (10 hours)

2.1. Types of Disasters: Natural (earthquakes, floods, cyclones) and anthropogenic (industrial accidents, nuclear incidents).

2.2. Disaster Risk Reduction (DRR): Strategies for minimizing disaster risks.

2.3. Disaster Management Cycle: Phases of disaster management: mitigation, preparedness, response, and recovery.

2.4. Institutional Frameworks: Roles of national and international agencies in disaster management. Case Studies: Analysis of major disasters : Prediction of cyclones in the Indian East coast.

Module 3: Climate Change Impacts and Adaptation (10 hours)

3.1. Impacts on Ecosystems: Effects on biodiversity, forests, and marine life.

3.2. Impacts on Human Systems: Agriculture, water resources, health, and infrastructure.

3.3. Vulnerable Populations: Impacts on marginalized and low-income communities.

3.4. Adaptation Strategies: Climate-resilient agriculture, water management, and urban planning. Climate Justice: Equity considerations in adaptation efforts.

Module 4: Mitigation Strategies and Policy Frameworks (8 hours)

4.1. Mitigation Measures: Renewable energy, energy efficiency, and carbon capture.

4.2. International Agreements: Kyoto Protocol, Paris Agreement, and their implications.

4.3. National Policies: India's National Action Plan on Climate Change (NAPCC) and state action plans.

4.3. Role of Technology and Innovation: Technological advancements in mitigation efforts. Public Awareness and Education: Strategies for promoting climate change awareness.

Module 5. PRACTICALS (9 hrs):

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4 hrs

Case studies on Floods of Kerala; Covid-19 Pandemic; Landslides in Kerala

Practicals 5 hours

1. Field Visit: Visit to a local disaster-prone area or climate-resilient project.
2. Simulation Exercise: Disaster response simulation using role-playing.
3. Data Analysis: Analysis of climate data and disaster statistics.
4. Project Presentation: Students present a project on climate adaptation or disaster risk reduction strategies.

Suggested Assignment Topics- Theory

1. Disaster management
2. Climate change
3. Impacts of Global warming
4. Biodiversity of Kerala
5. India as megadiversity centre

Suggested Assignment Topics- Practical

1. Reports after field visits
2. Projects on various pollution studies

Suggested readings	
Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Adger, W. N., et al. (2007). *Assessment of Adaptation Practices, Options, Constraints, and Capacity*. Cambridge University Press.
2	Coppola, D. P. (2015). *Introduction to International Disaster Management*. Elsevier.
3	Government of India (2008). *National Action Plan on Climate Change*. Ministry of Environment, Forest and Climate Change.
4	Houghton, J. (2009). *Global Warming: The Complete Briefing*. Cambridge University Press.
5	IPCC (2021). *Climate Change 2021: The Physical Science Basis*. Cambridge University Press.
6	Paul, B. K. (2003). *Environmental Hazards and Disasters: Contexts, Perspectives, and Management*. Wiley-Blackwell.
7	Smit, B., et al. (2001). *Adaptation to Climate Change in the Context of Sustainable Development and Equity*. Cambridge University Press.
8	UNFCCC (2015). *Paris Agreement*. United Nations Framework Convention on Climate Change.
9	Khullar D R, 2021. Environment and Disaster Management
10	Agrahari R P, 2023. Environmental Ecology, Bio-Diversity, Climate Change & Disaster Management, MaC Graw Hill.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practicals ➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions:

1. What is the greenhouse effect, and how does it contribute to global warming?
2. Identify two major anthropogenic activities that lead to global warming.
3. Explain the concept of microclimates and provide an example.
4. Differentiate between natural and anthropogenic disasters with examples.
5. Outline the four phases of the disaster management cycle.
6. Discuss the role of national and international agencies in disaster risk reduction.
7. Describe the impact of climate change on biodiversity.
8. Explain how climate change affects agriculture and water resources.

9. What are renewable energy sources, and how do they mitigate climate change?
10. Summarize the objectives of the Paris Agreement in addressing global warming.

6 Marks Questions:

1. Analyze the objectives and outcomes of the Paris Agreement in addressing global warming.
2. Describe the role of national and international agencies in disaster risk reduction.
3. Differentiate between natural and anthropogenic disasters with examples.
4. Discuss the direct and indirect impacts of global warming on the environment.
5. Discuss the vulnerability of marginalized communities to climate change impacts.

7 Marks Questions:

1. Evaluate the effectiveness of renewable energy sources in mitigating climate change.
2. Explain the effects of climate change on biodiversity and ecosystems.
3. Identify and explain two major anthropogenic activities that lead to global warming.
4. Outline the four phases of the disaster management cycle and their significance.
5. What is the greenhouse effect, and how does it contribute to global warming?

14 Marks Questions:

1. Explain the greenhouse effect and its role in global warming. Discuss the anthropogenic activities contributing to global warming and their implications for Earth's climate systems.

2. Analyze the various types of natural and anthropogenic disasters. Discuss the disaster management cycle and the roles of national and international agencies in disaster risk reduction and response.

3. Assess the impacts of climate change on ecosystems and human systems, with a focus on agriculture, water resources, health, and infrastructure. Discuss adaptation strategies and the concept of climate justice in addressing these challenges.

4. Evaluate the effectiveness of mitigation measures such as renewable energy, energy efficiency, and carbon capture in combating climate change. Discuss about various international agencies and agreements on Climate change.

5. Discuss the role of technology, innovation, and public awareness in addressing climate change. Evaluate the effectiveness of educational initiatives and policy frameworks in promoting sustainable practices and climate resilience.

Employability for the Course / Programme

It is one of the advanced courses which is very helpful in understanding the diversity of plant life

25	ENTRPRENEURESHIP IN COMPOST MAKING	KU4VACBOT125
VAC	**Semester : 4** **Hrs/week : 3 Theory**	**Credits : 3**

Course Pre-requisite:

1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Utilize appropriate composting methods tailored to specific organic waste types
CO2	Enhance Environmental Sustainability by selecting proper waste management system
CO3	Expand composting initiatives from small-scale setups to larger operations
CO4	Develop and implement business plans for sustainable and profitable composting ventures.

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3					√	√	√	√	√	√		
CO4								√	√	√	√	√

Course Description

This is an advanced botany course designed for UG students in general and BSc Zoology and BSc Forestry in particular. The aim of the course is to give basic knowledge about the diversity of plant life forms.

- *First module is giving basics of composting and its environmental benefits.*
- *Second module delves into the basic techniques of composting prevailing in India and abroad.*
- *Third module is giving directions to setup composting ventures.*
- *Fourth module is inducing the student to start a business plan on composting enterprises.*

This course will also provide opportunities to observe various types of composting present in our premises.

Course Objectives:

1. To gather knowledge on various composting techniques
2. To articulate the knowledge on decomposing microorganisms in solid waste management through composting.
3. To design and establish small- to large-scale composting systems.
4. To create business models on composting ventures.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 +0)	3 (45)	25	50	75

COURSE CONTENT

Module1: Introduction to Composting 9 Hrs

1.1. Definition and Importance of Composting: Understanding composting as a sustainable waste management practice. Microbes and other organisms in composting.

1.2. Environmental Benefits: Reduction of landfill waste, greenhouse gas emissions, and the role in soil health.

1.3. Types of Composting: Aerobic vs. anaerobic, vermicomposting, and their applications.

1.4. Composting Materials: Organic waste types, carbon to nitrogen ratio, and moisture content.

Module 2: Compost Production Techniques 10 Hrs

2.1. Composting Methods: Windrow, pit (Heap composting and Tank composting), and bin composting techniques.

2.2. Vermicomposting and importance: Introduction to earthworm species, bed preparation, and harvesting. Vermi wash.

2.3. Small- and Large-scale composting. Kitchen waste composting, farm waste composting.

2.4. Quality Parameters: Temperature, pH, moisture, and maturity indicators. Troubleshooting: Common issues like odor, pests, and improper decomposition.

Module 3: Practical Implementation and Scaling of Composting Ventures 10 hours

3.1. Site Selection and Setup: Choosing appropriate locations, infrastructure requirements, and equipment.

3.2. Operational Management: Daily operations, labor management, and inventory control.

3.3. Scaling Strategies: Expanding production capacity, diversifying product lines, and exploring new markets. Value addition of compost, activated compost, weed compost, compost sieving and packing

3.4. Sustainability Practices: Implementing eco-friendly practices and achieving sustainability goals. Composting Kerala model: Thumboormuzhi. Biocomposting Methods: Coimbatore method, Indore method, Bangalore method.

Module 4. Business Planning and Market Strategies for Compost Enterprises 7hrs

4.1. Business Model Development: Identifying target markets, value proposition, and revenue streams.

4.2. Legal and Regulatory Aspects: Licensing, certifications, and environmental regulations.

4.3. Marketing Strategies: Branding, pricing, distribution channels, and customer engagement.

4.4. Financial Planning: Cost analysis, pricing models, and profitability projections.

Module 5. PRACTICALS 9 hrs

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 4 hrs

Biodegradation mechanism in composting process- various new initiatives in composting, case studies.

Practicals 5 hrs

1. Biocomposting lab visits
2. Identification of vermicompost worms
3. preparation of vermiwash
4. Identification of different composting bins and equipment
5. A start up project proposal writing in composting
6. Prepare and submit an innovative model for composting

Suggested Assignment Topics- Theory

1. Biocomposting
2. Thumboormuzhi
3. Banglore model of biocomposting
4. Indore model of biocomposting
5. Meachanism in composting
6. Organisms in composting

Suggested Assignment Topics- Practical

5. Collection of photos and life histories of composting organisms
6. Exhibition and album preparations on successful composting methods.

Suggested readings

Sl. No	Title/Author/Publishers of the Books/ Online resources
1	Ayilara, M. S., Olanrewaju, O. S., Babalola, O. O., & Odeyemi, O. (2020). Waste Management through Composting: Challenges and Potentials. *Sustainability*, *12*(11), 4456. https://doi.org/10.3390/su12114456
2	Cummings D, 2015.Organic Composting Handbook: Techniques for a Healthy, Abundant Garden, Skyhorse Publishers
3	Dabral, M. (2025). Basics of Vermicomposting Business. Retrieved from Udemy
4	Entrepreneur India. (2025). The Complete Book on Organic Farming and Production of Organic Compost (3rd Edition). Retrieved from entrepreneurindia.co.in
5	Forsyth County Cooperative Extension. (2025). *Composting Basics*. Retrieved from forsyth.ces.ncsu.eduUdemyforsyth.ces.ncsu.edu
6	Gupta M K, 2007.Handbook of Organic Farming and Biofertilizers, ABD Publishers.
7	https://www.nyc.gov/assets/dsny/docs/nyc-master-composter-manual-mcm.pdf
8	Institute for Local Self-Reliance. (2025). Community Composting 101 Online Certificate Course. Retrieved from ilsr.org
9	Madhav V N, Geetha S and N Gangadhar, 2022. Biofertilizers and Organic Farming, BFC Publications
10	North Carolina Cooperative Extension. (2025). Composting Basics. Retrieved from forsyth.ces.ncsu.edu
11	Urban Worm Company. (2025). Commercial Worm Farm Course. Retrieved from urbanwormcompany.com
12	Wilson J, 2020. Composting: Sustainable and Low-Cost Techniques for Beginners. Drip Digital.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments	➢ Lecturing
➢ Collaborative learning-Group discussion	➢ ICT
➢ Field visits	➢ Practicals
	➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Questions

1. What is composting, and why is it important?
2. List two environmental benefits of composting.
3. Differentiate between aerobic and anaerobic composting.
4. What is the ideal carbon-to-nitrogen (C:N) ratio for composting?
5. Explain any two features of windrow composting method.
6. What is vermiwash, and how is it used?
7. Name one method for small-scale composting.
8. What temperature range is ideal for composting?
9. How does the Thumboormuzhi model of composting is different from other composting?
10. Name one biocomposting method.

6 Marks Questions

1. Detail the process of vermicomposting, including bed preparation, suitable earthworm species, and the benefits of vermiwash.
2. Discuss strategies for scaling composting operations, including site selection, operational management, and exploring new markets.
3. Discuss the environmental benefits of composting, focusing on its impact on landfill reduction and soil health.
4. Discuss the Indore method of composting, focusing on its layering process and the role of periodic turning.
5. Explain the Coimbatore method of composting, emphasizing its unique features and benefits.

7 Marks Questions

1. Compare aerobic and anaerobic composting methods, highlighting their differences and suitable applications.
2. Describe the ideal carbon-to-nitrogen (C:N) ratio for composting and its importance in the decomposition process.
3. Describe the Thumboormuzhi model of composting in Kerala, highlighting its community involvement and sustainability practices.
4. Explain the process of composting and its significance in sustainable waste management.
5. Outline the steps involved in windrow composting and its advantages for large-scale composting operations.

14 Marks Questions

1. Discuss the principles and environmental significance of composting.
2. Compare and contrast various composting methods, emphasizing their applications and advantages.
3. Elaborate on the Thumboormuzhi model of composting in Kerala and its impact on community waste management.
4. Analyze the business planning aspects of establishing a composting enterprise.
5. Explore scaling strategies for composting ventures, focusing on operational management and sustainability practices.

Employability for the Course / Programme

It is one of the foundation course in Botany to get an environmental awareness which is very helpful in the progression as an active social worker as well as an industrialist.

26	BIOFERTILISER AND MARKETING	KU4VACBOT126
VAC	Semester: 4 Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:
1. Knowledge in Biology at 10th Standard
2. Ability to write examination in English

Course Outcomes	
CO1	Apply Biofertilizer Knowledge in Agricultural Practices
CO2	Demonstrate Practical Skills in Biofertilizer Production
CO3	Ensure Quality Control in Biofertilizer Production
CO4	Design and Implement Biofertilizer-Based Business Models

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√	√	√				
CO3							√	√	√	√		
CO4								√	√	√	√	√

Course Description

This is a GFC VAC course in botany designed for all UG students. The aim of the course is to give basic knowledge in setting up of biofertilizer units and their business opportunities.

- *First module is an introduction to biofertilisers.*
- *Second module is dealing with the production techniques of biofertlisers.*
- *Third module is directing the stakeholders to the world of biofertiliser business.*
- *Fourth module is inducing the student for a start up in biofertliser venture.*

This course will provide you opportunities to observe diverse biofertliser techniques.

Course Objectives:
1. To gather knowledge on biofertilizers and their importance
2. To identify various types of biofertilizers
3. To understand mechanisms of enhancement of soil fertility and plant growth
4. To assess the benefits and limitations in developing business and marketing ventures in the field of biofertilisers.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3 +0 + 0 (45 +0 + 0)	3 (45)	25	50	75

COURSE CONTENT

Module 1: Introduction to Biofertilizers (8 hours)

1.1. Definition and Importance: Understanding biofertilizers as sustainable alternatives to chemical fertilizers.

1.2. Types of Biofertilizers: Nitrogen fixers (e.g., *Rhizobium, Azotobacter*), phosphorus solubilizers, potassium mobilizers, mycorrhizae, and cyanobacteria.

1.3. Mechanisms of Action: How biofertilizers enhance soil fertility and plant growth.

1.4. Benefits and Limitations: Advantages of biofertilizers in agriculture and potential challenges.

Module 2: Production Techniques of Biofertilizers (10 hours)

2.1. Microbial Strain Selection: Criteria for selecting effective microbial strains for biofertilizer production. Isolation and Purification: Techniques for isolating and purifying beneficial microorganisms.

2.2. Mass Production Methods: Solid-state fermentation and submerged fermentation techniques.

2.3. Formulation Types: Carrier-based and liquid formulations; advantages and disadvantages.

2.4. Quality Control: Standards for biofertilizer quality, including microbial count, viability, and shelf life.

Module 3: Business Planning and Marketing of Biofertilizers (10 hours)

3.1. Market Analysis: Identifying target markets, customer needs, and competition.

3.2. Business Model Development: Creating a sustainable business model for biofertilizer production.

3.3. Regulatory Compliance: Understanding national and international standards for biofertilizer production and marketing.

3.4. Marketing Strategies: Branding, pricing, distribution channels, and promotional tactics. Sales and Distribution: Establishing sales networks and partnerships with agricultural stakeholders.

Module 4: Practical Implementation and Scaling of Biofertilizer Ventures (8 hours)

4.1. Site Selection and Infrastructure: Choosing appropriate locations and setting up production facilities.

4.2. Operational Management: Managing production processes, inventory, and quality assurance.

4.3. Scaling Strategies: Expanding production capacity and diversifying product offerings.

4.4. Sustainability Practices: Implementing eco-friendly practices and achieving sustainability goals.

Module 5. TEACH SPACE (9 hrs):

This module is having a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Theory 2hrs

Case study: Successful stories on biofertilizer technique and marketing

Practicals 7 Hrs

- Production Demonstration: Demonstrating the production of biofertilizers using different methods.
- Quality Control Testing: Conducting tests to assess the quality of produced biofertilizers.
- Market Survey: Conducting surveys to understand market demand and customer preferences.

- Business Plan Presentation: Developing and presenting a business plan for a biofertilizer enterprise.

Suggested Assignment Topics- Theory

1. Biofertilizer
2. Mechanism of decomposition used in biofertilizer technique
3. Microorganisms in biofertilizer tehcnology

Suggested Assignment Topics- Practical

1. Survey on biofertliser industry
2. Feasibility study on biofertilizer marketing

Suggested readings

Sl. No	Title/Author/Publishers of the Books/ online resources
1	Amrita Vishwa Vidyapeetham. (2025). Biofertilizer Technology. Retrieved from amrita.edu
2	B. N. Johri and V. K. Sharma (2014). *Biofertilizers: Commercial Production Technology and Quality Control*, Springer.
3	BASIC BIOFERTILIZER TECHNOLOGY (Skill Enhancement Course). (2025). Retrieved from biotech.iisuniv.ac.in
4	Centurion University. (2025). Bio-Fertilizer Preparation – Courseware. Retrieved from courseware.cutm.ac.in
5	Gupta M K, 2007.Handbook of Organic Farming and Biofertilizers, ABD Publishers.
6	https://www.nyc.gov/assets/dsny/docs/nyc-master-composter-manual-mcm.pdf
7	Institute for Local Self-Reliance. (2025). Community Composting 101 Online Certificate Course. Retrieved from ilsr.org
8	Institute of Agriculture, Kumulur. (2025). *Commercial Courses*. Retrieved from tnau.ac.inmaraugusthinosecollege.org
9	Madhav V N, Geetha S and N Gangadhar, 2022. Biofertilizers and Organic Farming, BFC Publications
10	Mar Augusthinose College. (2025). Biofertilizers and Its Applications. Retrieved from maraugusthinosecollege.org
11	Organic Farming – Courseware. (2025). Retrieved from course.cutm.ac.inbiotech.iisuniv.ac.in
12	Pankaj Bhatt and Ajar Nath Yadav (2019). *Biofertilizers for Sustainable Agriculture*, Springer Publication.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion ➢ Field visits	➢ Lecturing ➢ ICT ➢ Practicals ➢ Demonstrations

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Sample Questions to test Outcomes.

2 Marks Question

1. Define biofertilizers.
2. Explain the term 'carrier-based formulation' in biofertilizer production.
3. Identify one advantage of using biofertilizers over chemical fertilizers.
4. List two nitrogen-fixing bacteria used as biofertilizers.
5. Mention a regulatory aspect important in biofertilizer marketing.
6. Name a free-living nitrogen-fixing cyanobacterium used as a biofertilizer.
7. Write down the primary purpose of seed treatment with biofertilizers.
8. What is the role of biofertilizers in integrated nutrient management?
9. What is meant by mycorrhizal fungi? Mention its role in biofertilization.
10. Give a brief account on the significance of quality control in biofertilizer production.

6 Marks Questions:

1. Outline the steps involved in the production of biofertilizers.
2. Discuss the importance of quality control in biofertilizer production.
3. Explain the regulatory compliance requirements for biofertilizer production and marketing.
4. What are biofertilizers, and how do they contribute to sustainable agriculture?
5. What are the key components of a business model for biofertilizer production?

7 Marks Questions:

1. Compare carrier-based and liquid formulations of biofertilizers.
2. Describe the different types of biofertilizers and their specific functions.
3. Explain the mechanisms through which biofertilizers enhance plant growth.
4. Describe the strategies for scaling up biofertilizer production operations.
5. What are the advantages and limitations of using biofertilizers in agriculture?

14 Marks Questions

1. Discuss the role of biofertilizers in sustainable agriculture.
2. Compare and contrast different types of biofertilizers and their applications.
3. Explain the methods of biofertilizer production and quality control measures.
4. Analyze the business planning and marketing strategies for biofertilizer enterprises.
5. Evaluate the challenges and strategies in scaling biofertilizer production.

Employability for the Course / Programme

It is a basic course in Botany for becoming an entrepreneur in the field of biofertilizer production and marketing.

27	Agri-based Microenterprises		KU6VACBOT127
VAC	Semester: 6	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

5. Knowledge in Biology at 101-199 level
6. Ability to write examination in English

Course Outcomes	
CO1	Demonstrate familiarity with the institutional, policy and regulatory environment for MSMEs and agribased enterprises in India.
CO2	Compare and contrast various agribased production and processing enterprise models, their opportunities and constraints.
CO3	Construct a value-chain map for an agribased product or enterprise and determine key intervention points for value addition and market access.
CO4	Prepare a concise business plan for an agribased micro-enterprise, comprising key sections such as market opportunity, SWOT, operational plan, technical/financial appraisal.
CO5	Formulate strategic recommendations for the growth, sustainability and integration of agribased MSMEs, considering marketing, institutional linkages, sustainability and scaling potential.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course is designed to equip undergraduate students with a comprehensive understanding of agri-based micro, small and medium enterprises (MSMEs).

- *First module is pivotal for setting the conceptual and analytical basis for the understanding of microenterprises linked to agriculture sector.*
- *Second module focusses on the production side of agribased microenterprises.*
- *Third module is discussing the core concepts of processing and manufacturing in the agribased context.*
- *Fourth module focuses on the supportive ecosystem and growth strategies for agribased MSMEs.*

It emphasises on the conceptual clarity, practical relevance, and the interconnections between agriculture, enterprise, value-addition and rural livelihoods.

Course Objectives:

1. Explain the evolution, legal framework and classification of MSMEs in India, especially in the agribased context.

2. Identify and evaluate different types of agribased micro-enterprises (production, processing, forest, service), their roles and linkages in rural livelihoods and value chains.
3. Map agricultural value-chains (input → production → processing → distribution → marketing) and apply business models (sole proprietorship, SHG, cooperatives, micro-units) to agribased enterprises.
4. Develop a basic business or project plan for an agribased micro-enterprise, including market research, SWOT/feasibility analysis and financial/technical/social appraisal.
5. Analyse the supportive ecosystem (input supply, marketing, institutional support, sustainability strategies), and propose pathways for sustainable and scalable agribased MSME growth.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Foundations of MSMEs and Business Planning (9 Hours)

1.1.MSME Fundamentals: Evolution and relevance of MSMEs in India's rural economy. Legal framework: Definition, classification, and scope as per the MSME Development Act, 2006. Distinction between micro, small, and medium enterprises.

1.2. Agribased Microenterprises: Types: Crop, livestock, agro-processing, forest-based, and service-oriented enterprises. Role in value addition, employment, and rural development

1.3. Value and Supply Chains in Agriculture: Structure: Input → Production → Processing → Distribution → Marketing. Integration and coordination mechanisms. Business models: Sole proprietorship, cooperatives, SHGs, and micro-units

Opportunity Identification & Business Planning: Market research tools, SWOT and feasibility analysis. Components of a project report and business plan. Financial, technical, and social appraisal of projects

Module 2: Agribased Production Enterprises (9 Hours)

2.1. Overview of Production Microenterprises: Importance, focus areas, and challenges (resources, technology, markets)

2.2.Crop-based Microenterprises: Niche production units: vegetables, spices, fruits, medicinal & aromatic plants. Linkages with processing and direct marketing

2.3. Livestock and Poultry-based Enterprises: Small-scale dairy, goat, piggery, poultry, and duck farming. Local supply models and cooperative integration

2.4.Apiculture and Allied Units: Honey production, beeswax, and value-added apiculture products. Environmental and income diversification roles

Module 3: Processing and Manufacturing Enterprises (9 Hours)

3.1. Processing & Manufacturing Concepts: Value addition pathways, technology choices, quality standards, and challenges.

3.2.Food Processing Micro-units: Examples: Spice grinding, oil extraction, pickles, snacks, juices, dehydrated foods. Packaging, branding, and market linkages.

3.3.Forest and Non-Timber Forest Product (NTFP) Enterprises: Processing of honey, medicinal herbs, bamboo, resin, essential oils. Sustainable harvesting and community-based enterprises.

3.4.Agri-resource Handicrafts & Artisanal Units: Mat-making, coir products, fiber crafts,

eco-friendly souvenirs. Role in rural tourism and women's entrepreneurship.
Module 4: Supportive MSME Sectors, Marketing, and Sustainability (9 Hours) 4.1. Input Supply and Agro-support Services: Seed, feed, fertilizer, and bio-input production micro-units. Service-based microenterprises: soil testing, custom hiring, veterinary and agronomy services 4.2.Marketing and Distribution Models: Farm-gate retail, local markets, aggregators, digital platforms. Branding, packaging, and logistics for small enterprises. 4.3.Supportive & Integrative Institutions: Cooperatives, SHGs, and producer groups. Microfinance, insurance, and training hubs (NGOs, R&D centers). 4.4.Sustainability and Growth Strategies: Organic and inclusive approaches, renewable energy use. MSME cluster development, cooperative models, and agritourism integration
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 3Hrs** Success stories of agribased MSMEs. Weather and climate change and Agribased industries. Agritourism and its utility in Kerala. **Practical 10 Hrs** 1. Visit to Agribased MSMEs 2. Internship 3. Collection of reports on successful stories of MSME and their documentation.

Suggested Assignment Topics- Theory

1. Government support for MSMEs
2. Significance of SHGs
3. Successful stories of agribased MSMEs
4. Seed certification and its importance

Suggested Assignment Topics- Practical

1. Agribased MSME visit for internship
2. Survey on Agribased industry and their SWOT analysis

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	https://egyankosh.ac.in/bitstream/123456789/104874/1/Unit%207.pdf
2	Babel, R. (2021). Treatise on Micro, Small and Medium Enterprises. Bloomsbury Professional India.
3	Dana, L.-P., Sharma, N., & Acharya, S. R. (Eds.). (2020). Organising entrepreneurship and MSMEs across India. World Scientific Publishing Company.
4	Ghosh, A. (2025). Marketing practices in micro and small food processing enterprises. Eliva Press.
5	Gulati, A., Ganguly, K., & Wardhan, H. (2022). Agricultural value chains in India: Ensuring competitiveness, inclusiveness, sustainability, scalability, and improved finance. Springer.
6	Mani, G. (Ed.). (2017). Financing agriculture value chains in India: Challenges and opportunities. Springer.
7	Mayo, H. & Longbow, K. (2025). Agricultural value chain. Kruger Brentt Publisher UK.
8	NIIR Board of Food Technologists. (n.d.). 55 most profitable micro, small, medium scale food processing (processed food) projects and agriculture based business ideas for startup. NIIR Project Consultancy Services.
9	Ojha, P. K., Mishra, D., Ojha, P., Bajpai, N. K., & Singh, R. K. (Eds.). (2025). Rural transformation through agri-enterprise: Empowering farmers and youth – Focus on grassroots entrepreneurship and youth involvement. New India Publishing Agency.

10	Panigrahy, S. R., & Singh, B. (2017). Agro-entrepreneurship. Scientific Publishers.
11	Parthiban, K. T., & Seenivasan, R. (2021). Plantation and agroforestry: Pulpwood value chain approach. Scientific Publishers.
12	Sharma, A., Das, S., Chand, K., Rohith, G. V., & Singh, S. G. (2025). Sustainable approach to agribusiness management: Green strategies & rural entrepreneurship. TTPP India.
13	Sharma, M. C. (2019). Entrepreneurship in livestock & agriculture. CBS Publishers & Distributors.
14	Shravanthi, A. R., Maheshwari, K. S., Kumari, T., & Deshmukh, S. S. (2025). Income augmentation through small agribusinesses. NIPA.
15	Sudheer, K. P., & Indira, V. (Eds.). (2022). Entrepreneurship development in food processing. CRC Press / NIPA.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion. ➢ Field visits and documentation.	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

Students will understand ecosystem-level linkages that support agribased MSMEs and be able to propose sustainable and scalable models for rural enterprise development.

28	**Indigenous plants: their Identification and utility**		**KU6VACBOT128**
VAC	**Semester: 6**	**Hrs/week: 3 Theory**	**Credits: 3**

Course Pre-requisite:

1. Knowledge in Biology at 201-299 level
2. Ability to write examination in English

Course Outcomes	
CO1	Distinguish between indigenous, exotic, and naturalized species in local ecosystems.
CO2	Identify key indigenous plant species using morphological and digital tools.
CO3	Document and interpret traditional plant knowledge through ethnobotanical fieldwork.
CO4	Demonstrate understanding of economic, medicinal, and cultural applications of native flora.
CO5	Recommend conservation and value-addition strategies aligned with sustainable development goals (SDGs).

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course bridges classical botany with ethnobotanical wisdom, encouraging students to value native flora as vital ecological and cultural resources.

- *First module provides the foundational understanding of what constitutes indigenous flora and why it is critical for India's biodiversity and culture.*
- *Second module trains students in plant identification, taxonomy, and classification of native flora.*
- *Third module examines the economic, medicinal, and cultural uses of indigenous plant species.*
- *Last module fosters participatory approaches linking conservation, livelihood, and education.*

This course will provide you opportunities to combine scientific taxonomy, field-based documentation, and socio-cultural insights to understand how indigenous species shape livelihoods, health, and heritage.

Course Objectives:

1. Understand the concept, scope, and ecological importance of indigenous flora in India.
2. Apply taxonomic principles and field methods to identify and classify native plants.
3. Analyze ethnobotanical relationships between plants and indigenous communities.

4. Evaluate the diverse utilities of indigenous plants in food, medicine, culture, and industry.
5. Examine conservation challenges and propose sustainable strategies for indigenous plant use.

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Introduction to Indigenous Flora and Ethnobotany 1.1.Concept and Scope of Indigenous Flora: Definition, characteristics, and importance of indigenous and endemic species. Difference between indigenous, exotic, and naturalized plants. 1.2.Biodiversity and Plant Distribution in India: Major phytogeographical zones; hotspot regions (Western Ghats, Himalayas, NE India). Role of traditional ecosystems in maintaining native flora. 1.3.Principles of Ethnobotany: Relationship between local communities and plants. Cultural, spiritual, and traditional dimensions of plant use. 1.4.Documentation and Traditional Knowledge Systems: Methods of documenting indigenous knowledge (field surveys, herbarium, interviews).Intellectual Property Rights (IPR) and protection of traditional plant knowledge.
Module 2: Identification and Classification of Indigenous Plants 2.1.Taxonomic Principles and Tools: Morphological features, binomial nomenclature, use of taxonomic keys and floras. Herbarium preparation and field documentation techniques. 2.2.Major Plant Families with Indigenous Species: Common native representatives from Fabaceae, Poaceae, Asteraceae, Euphorbiaceae, and Rutaceae. Diagnostic characters and field identification cues. 2.3.Local and Vernacular Identification Practices: Folk classification systems used by indigenous and rural communities. Local naming conventions and cultural references. 2.4.Digital and Field-based Identification Tools: Use of mobile apps, botanical databases (e.g., BSI, India Biodiversity Portal).GIS mapping of local flora and ethnobotanical surveys.
Module 3: Utility of Indigenous Plants 3.1.Medicinal and Nutraceutical Value: Indigenous medicinal plants and their active principles. Use in traditional health systems: Ayurveda, Siddha, Unani, folk medicine. 3.2.Food, Fodder, and Fiber Plants: Wild edible species, indigenous grains, tubers, and leafy vegetables. Fodder and fiber- yielding native species and their rural applications. 3.3.Timber, Gum, Dye, and Aromatic Plants: Indigenous trees yielding timber, resin, gum, dye, and essential oils. Role in local crafts and cottage industries. 3.4.Cultural, Ritual, and Aesthetic Uses: Sacred groves, ritual plants, and symbolic vegetation in cultural practices. Indigenous plants in art, ornamentation, and traditional landscaping.
Module 4: Conservation, Sustainable Use, and Value Addition 4.1.Threats and Conservation Challenges: Habitat loss, invasive species, overharvesting, and climate change impacts. Conservation status (IUCN categories) of key indigenous species. 4.2.In-situ and Ex-situ Conservation Practices: Sacred groves, community forests, and

biosphere reserves. Botanical gardens, seed banks, and tissue culture of indigenous species. 4.3.Sustainable Utilization and Enterprise Development: Value addition and commercialization of indigenous plant products. Role of MSMEs, SHGs, and NGOs in promoting native plant-based livelihoods. 4.4.Policy, Education, and Community Involvement: National Biodiversity Act, 2002; Access and Benefit Sharing (ABS). Participatory conservation and integration into curricula and awareness campaigns.
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 3 Hrs** Key local plants in home district, including aquatic, terrestrial, riparian species **Practical 6 Hrs** 1. Field visits to find out the useful plants 2. Survey on utilitarian aspects of plants 3. Dichotomous key preparation 4. Identification of plants using flora

Suggested Assignment Topics- Theory

1. ABS and successful stories
2. Ehtno-medicines and folk medicines
3. Phytochemistry and bioactive compounds of dasapushpa and Thriphala

Suggested Assignment Topics- Practical

1. Phytochemistry of folk medicines
2. Photodocumentation of ethnomedcines

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Balick, M. J., & Cox, P. A. (2020). *Plants, people, and culture: The science of ethnobotany* (2nd ed.). CRC Press.
2	Bhatnagar, S. P., & Moitra, A. (2018). *Diversity of Indian flora: Structure, function, and evolution.* NIPA Publishers.
3	Cox, P. A. (2019). *Ethnobotany: Principles and applications.* Wiley-Blackwell.
4	Hooker, J. D. (1904). *Flora of British India* (Vols. 1–7). Reeve & Co.
5	Jain, S. K. (2010). *Manual of ethnobotany* (3rd ed.). Scientific Publishers (India).
6	Jain, S. K., & Rao, R. R. (1977). *A handbook of field and herbarium methods.* Today and Tomorrow's Printers & Publishers.
7	Karthikeyan, S., Jain, S. K., Nayar, M. P., & Sanjappa, M. (1989). *Florae Indicae enumeratio: Monocotyledonae.* Botanical Survey of India.
8	Kumar, H. D. (2016). *Plant diversity and conservation.* Affiliated East-West Press.
9	Martin, G. J. (2010). *Ethnobotany: A methods manual.* Routledge.
10	Pandey, B. P. (2021). *Taxonomy of angiosperms.* S. Chand & Company Ltd.
11	Parthasarathy, V. A., & Parthasarathy, K. (2020). *Medicinal plants: Utilization and conservation.* Pointer Publishers.
12	Puri, S. (2022). *Indian biodiversity and traditional knowledge systems.* Springer Nature.
13	Rawat, G. S. (2015). *Conservation and management of tropical forests and biodiversity.* NIPA Publishers.
14	Singh, J. S., & Singh, S. P. (2017). *Forest ecosystems and biodiversity of India.* Springer Nature.
15	Tiwari, K. C., & Baruah, R. (2016). *Ethnobotany of Northeast India.* Scientific Publishers.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

This course enhances employability by equipping students with applied botanical, ethnobotanical, and conservation skills relevant to multiple sectors.

29	Wetland and Laterite Hill Ecology		KU6VACBOT129
VAC	Semester: 6	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	**Classify and map different wetland types** in Kerala based on ecological and geographical parameters.
CO2	**Describe and compare the structural and functional attributes** of lateritic hill ecosystems and their associated biota.
CO3	**Evaluate the ecological services** of wetlands and lateritic landscapes, including water regulation, biodiversity conservation, and cultural values.
CO4	**Assess threats and propose sustainable management strategies**, applying both scientific and community-based approaches.
CO5	**Engage in informed discussions or research projects** related to wetland and laterite hill conservation, guided by current governance policies and scientific literature.

Mapping of Course Outcomes to PSOs/POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√

Course Description

This course introduces the ecological characteristics, biodiversity, and conservation importance of Kerala's wetlands and laterite hill ecosystems, emphasizing their environmental functions and sustainable management.

- *First module explores the diversity, classification, and ecological dynamics of wetlands across Kerala's landscapes.*
- *Second module introduces the formation, vegetation, and ecological uniqueness of laterite hill systems in Kerala.*
- *Third module examines the ecological services of wetlands and laterite hills, and the major threats influencing their sustainability.*
- *Fourth module focuses on governance, participatory management, and contemporary research trends in wetland and laterite hill conservation.*

This course will provide you opportunities to know more about the diversity of wetlands and laterite hillocks.

Course Objectives:

1. Understand the diversity and classification of wetlands across Kerala's physiographic regions, including their hydrological and ecological characteristics.
2. Explain the geomorphology, formation processes, and vegetation patterns of laterite hill systems in Kerala.

3. Analyze the ecological functions and services provided by wetlands and laterite hills, and evaluate their contribution to local and regional sustainability.
4. Identify and assess major anthropogenic and natural threats affecting these ecosystems, such as land-use change, pollution, and climate variability.
5. Critically examine governance frameworks and participatory conservation strategies, integrating traditional knowledge and contemporary research in ecosystem management

Credit			Teaching Hours		Assessment		
L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Wetland Ecosystems of Kerala: 9hrs

1.1. Types and Distribution of Wetlands in Kerala: Ramsar and non-Ramsar sites; freshwater, estuarine, and coastal wetlands (Vembanad, Ashtamudi, Sasthamkotta).

1.2. Structure and Function of Wetland Ecosystems: Hydrology, nutrient cycling, productivity, and biodiversity.

1.3. Floral and Faunal Diversity: Macrophytes, plankton, aquatic birds, fishes, and invertebrates unique to Kerala wetlands. Mangroves of Kerala. True mangroves and mangrove allies.

1.4. Human–Wetland Interactions: Agriculture, aquaculture, and traditional livelihood practices (pokkali, kole, and backwater systems).

Module 2: Laterite Hill Ecosystems of Kerala 9hrs

2.1. Formation and Distribution of Laterite Hills: Geological origin, soil characteristics, and topography (Kannur, Kozhikode, Kasaragod belts). Salient features of Laterite Hillocks.

2.2. Flora and Fauna of Laterite Habitats: Xerophytic and endemic species; adaptations to harsh soil and climatic conditions.

2.3. Microhabitats and Ecological Niches: Rock pools, seasonal ponds, and micro-endemism.

2.4. Anthropogenic Impacts and Habitat Degradation: Quarrying, mining, deforestation, and urbanization threats.

Module 3: Ecosystem Services, Threats, and Conservation Strategies 9hrs

3.1. Ecosystem Services and Functions: Carbon sequestration, flood control, aquifer recharge, and cultural significance.

3.2. Environmental Threats and Pressures: Land-use change, pollution, eutrophication, invasive species, and climate change.

3.3. Biodiversity Loss and Species Endangerment:Decline of native flora and fauna; case studies from Vembanad and Madayipara.

3.4. Conservation Approaches: Restoration ecology, protected area networks, and community-based wetland and hill management.

Module 4. Module 4: Policy, Sustainable Management, and Research Perspectives: 9hrs

4.1.National and State Policies: Wetlands (Conservation and Management) Rules, 2017; Kerala State Biodiversity Board initiatives.

4.2.Participatory and Integrated Management: Role of panchayats, local communities, and NGOs in conservation.

4.3.Sustainable Development and Ecotourism: Nature-based tourism, livelihood integration,

and biodiversity-friendly enterprises. 4.4.Recent Research and Monitoring Tools: GIS mapping, remote sensing, environmental indicators, and ecological restoration studies.
Module 5. TEACH SPACE 9 Hrs This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***. **Theory 3Hrs** Wetland Ecotourism points – Kadalundi, Kumbalangi. Laterite hill areas with summit wetlands northern Kerala. **Practical 6 Hrs** 1. Visit to wetlands and laterite hillocks 2. Survey of flora and fauna in these two ecosystems 3. Internship at any wetland ecotourism points 4. Pollution studies

Suggested Assignment Topics- Theory

1. Florisitc diversity of these areas
2. Faunal diversity

Suggested Assignment Topics- Practical

1. PBR preparation
2. Ecological survey

Sl. No	**Title/Author/Publishers of the Book specific to the module**
1	Balachandran, K. K., Joseph, T., & Nair, S. M. (2005). *Ecology and conservation of Kerala wetlands.* Centre for Earth Science Studies (CESS).
2	Chandran, M. D. S. (2018). *Lateritic landscapes of coastal Western Ghats: Ecology and management.* Indian Institute of Science.
3	Cess, K. (2000). *Wetlands of Kerala: Conservation and management.* Centre for Earth Science Studies.
4	Gopal, B. (2013). *Wetlands: Ecology and management.* Springer.
5	Gopalan, R., & Krishnamoorthy, K. K. (2001). *Ecology of tropical ecosystems in India.* Scientific Publishers.
6	Junk, W. J., An, S., Finlayson, C. M., Gopal, B., Květ, J., Mitchell, S. A., Mitsch, W. J., & Robarts, R. D. (Eds.). (2013). *Wetlands: Ecosystem services, restoration and wise use.* Springer.
7	Krishna, N. P., & Binoy, C. F. (2017). *Flora of Kerala wetlands.* Kerala Forest Research Institute (KFRI).
8	Kumar, A., & Padhy, P. K. (2016). *Wetland ecology: Indian perspectives.* Discovery Publishing House.
9	Mani, M. S. (2019). *Ecology and biogeography in India.* Springer Nature.
10	Nair, N. C., & Daniel, P. (1986). *The floristic diversity of Kerala, India.* Botanical Survey of India.
11	Nayar, T. S. (2019). *Flowering plants of Kerala: A handbook.* Tropical Botanic Garden and Research Institute (TBGRI).
12	Ramachandran, V. S. (2007). *Flora of Cannanore District, Kerala.* Botanical Survey of India.
13	Singh, J. S., & Gupta, S. R. (2017). *Ecology, environment and resource conservation.* S. Chand.
14	Balachandran, K. K., et al. (2008). "Heavy metal accumulation in sediments of

	wetlands of Kerala." *Environmental Monitoring and Assessment, 147*(1–3), 11–25.
15	Chandran, M. D. S., & Ramachandra, T. V. (2014). "Laterite hill ecology of coastal Western Ghats: Biodiversity significance." *Journal of Threatened Taxa, 6*(5), 5713–5726.
16	Finlayson, C. M., & Spiers, A. G. (2018). "Global wetland inventory and assessment: Past, present, and future." *Marine and Freshwater Research, 69*(12), 1867–1885.
17	Gopalan, R., & Nair, S. M. (2009). "Carbon dynamics in Kerala's wetland ecosystems." *Indian Journal of Environmental Sciences, 13*(2), 77–85.
18	Jayasree, S., & Nair, P. K. (2020). "Biodiversity of Madayipara laterite hill, North Kerala: A hotspot of endemism." *Indian Forester, 146*(4), 322–332.
19	KFRI. (2015). *Status report on the wetlands of Kerala.* Kerala Forest Research Institute.
20	Krishnan, P. (2019). "Ecohydrology of coastal wetlands in Kerala." *Hydrobiologia, 829*(1), 151–168.
21	Nair, A., & Radhakrishnan, M. (2016). "Community participation in wetland conservation: Lessons from Vembanad." *Journal of Environmental Management, 181*(1), 612–620.
22	Ramachandra, T. V., & Chandran, M. D. S. (2020). "Biodiversity, threats, and conservation strategies of lateritic plateaus of Western Ghats." *Current Science, 118*(3), 415–425.
23	Sreelekha, S., & Thomas, J. (2021). "Climate change impacts on Kerala's wetlands and adaptive strategies." *Environmental Science and Policy, 121*(1), 95–108.

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Hands-on experiments ➢ Collaborative learning-Group discussion	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

This course equips students with applied ecological and conservation skills relevant to employment in biodiversity assessment, environmental consultancy, wetland management, and sustainable landscape planning sectors

30	Apiculture	KU6VACBOT130

VAC	Semester: 6	Hrs/week: 3 Theory	Credits: 3

Course Pre-requisite:

1. Knowledge in Biology at 101-199 level
2. Ability to write examination in English

Course Outcomes	
CO1	Students will get overall idea of apiculture
CO2	Able to identify different species of honey bees based on their morphology, colony structure and their behaviour
CO3	Ability to configure and maintain hives effectively
CO4	Ability to extract and process honey using multiple methods
CO5	Skill in basic quality assessments of hive products
CO6	Awareness on beekeeping business plan and knowledge on institutional support systems

Mapping of Course Outcomes to PSOs/Pos

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	√	√	√									
CO2			√	√	√	√						
CO3							√	√	√	√		
CO4								√	√	√	√	
CO5									√	√	√	√
CO6										√	√	√

Course Description

This is an introductory biology course with multidisciplinary nature designed for all UG Students

- *First module is dealing with the introductory knowledge on bee keeping*
- *Second module delves into the biology of bees and their behaviour*
- *Third module is giving an elaborate knowledge on tools and techniques in apiculture.*
- *Fourth module is giving an idea for the students on entrepreneurship and economics of apiary management.*

This course will provide students opportunities to handle the apiaries and also to become an entrepreneur in commercial bee keeping.

Course Objectives:

1. To develop overall idea on Apiculture
2. To develop practical skills in identification, handling honey bees, colony separation and artificial feeding.
3. To familiarize the students various products of apiculture like honey, royal jelly, bee wax etc.
4. To know about startups in Apiculture

Credit	Teaching Hours	Assessment

L/T	P/I	Total	L/T/P	Total	CCA	ESE	Total
3	0	3	3+ 0+ 0 (45+ 0 + 0)	3	25	50	75

COURSE CONTENT

Module 1: Introduction to Apiculture 10 hrs

1.1. Apiculture: Definition, History, Scope and importance, Central Bee Research and Training Institute Pune and its activities.
1.2. Traditional and modern bee keeping. Hive types: Newton, Langstroth; setup, maintenance, seasonal management
1.3. Products of Apiculture: Nutritive value of different types of honey. Uses of bee wax, propolis and royal jelly. Bee pollination and its economics: Examples of honey bee pollinated crops. Effect on crop yields and quality of agricultural and horticultural crops.
1.4. Bee Botany: Introduction, multiplication and propagation of bee plants and study the general floral biology of bee plants (*Manihot glaziovii*, *Antigonon leptopus*) for reducing artificial feeding during starvation. Importance of protecting the honey bees: Bee friendly gardening. Apiculture in rubber plantations. Bee pasturage or bee forage. Melissopalynology

Module 2: Biology of Honey Bees 10 hrs

2.1. Type of honey bees and their morphology and colony characteristics- *Apis florea, Apis dorsata, Apis mellifera, Apis cerana indica, Trigona iridipennis* (indigenous and exotic), local varieties of honey bees.
2.2. Bee anatomy, life cycle stages, castes, and colony organization of *Apis dorsata, Apis mellifera, Apis cerana indica.*
2.3. Bee behaviour: foraging, waggle dance, swarming dynamics and migration.
2.4. Enemies of honey bees (ants, wax moths, bears, mites, lizards and wasps). Diseases: identification and symptoms of American foul brood and European foul brood, Nosema, Thai sac brood virus, Sac brood virus. Prevention and control measures.

Module 3: Bee Keeping practices and Equipments 9 hrs

3.1. Apiary planning: site selection & bee species matching to local climate.
3.2. Tools and modern appliances; Bee box types and parts, smokers, centrifuge, knife, queen cage, queen gate. indigenous honey extraction techniques. Handling of colonies. Control strategies: chemical, biological, and cultural.
3.3. Harvesting honey: techniques, preservation, and quality testing.
3.4. Post harvesting: moisture reduction, packing and storing, honey testing (physical and chemical methods). Honey marketing.

Module 4: Economics, Entrepreneurship and Policy 7 **hrs**

4.1.Economics of beekeeping: cost structures, income potential, value chains
4.2.Government schemes, financing, and self-employment support. Entrepreneurship in apiculture. Procedure for doing Startup Bee Keeping Business.
4.3.Role in crop pollination and agricultural productivity.
4.4.Business plan development and marketing strategies

Module 5. TEACH SPACE 9 Hrs

This module is a list of suggested activities that helps to achieve the aim, objectives and outcome of the course; which will be determined by the concerned teacher. Assessment for this module is ***strictly internal***.

Practical 9 Hrs

1. Field visits to commercial apiaries & extension centers
2. Floriculture mapping for bee nutrition
3. Bee behavior observation
4. Student group project: pitch a start-up plan

Suggested Assignment Topics- Theory

1. Comparative life cycles of various bees
2. Various hive types
3. Honey collection and extraction methods
4. Preservation and packing of bee products
5. Mellissopalynlogy

Suggested Assignment Topics- Practical

1. Poster making on Honey extraction and quality assessment
2. Methods to check adulteration in honey
3. Practising apiculture

Sl. No	Title/Author/Publishers of the Book specific to the module
1	Abroi, D. P. (2010). *Beekeeping: A comprehensive guide to bees and beekeeping.* Scientific Publishers (India).
2	Arumugam, N., Jayashree, K. V., & Tharadevi, C. S. (n.d.). *Beekeeping.* Saras Publications.
3	Bisht, D. S. (n.d.). *Apiculture.* Indian Council of Agricultural Research (ICAR), New Delhi.
4	Devapriya, S. K., Thomas, A., & Amritha, V. S. (2020). Entrepreneurial potential of apipreneurs in South Kerala. *Journal of Extension Education, 32*(3), 6515–6519. https://doi.org/10.26725/JEE.2020.3.32.6515-6519
5	Haddon Smith. (2015). *Beekeeping: An introduction to building and maintaining honeybee colonies* [Kindle edition].
6	Prost, P. J. (1962). *Apiculture.* Oxford & IBH Publishing, New Delhi.
7	Roger Morse. (1990). *The ABC & XYZ of bee culture: An encyclopaedia of beekeeping.* A. I. Root Company.
8	Sheikh, M. S. (2023). *Apiculture: Skill enhancement course.* Global Net Publications.
9	Singh, S. (n.d.). *Beekeeping in India.* Indian Council of Agricultural Research (ICAR), New Delhi.
10	Tamilselvi, M., & Abdul Jaffer Ali, H. (2018). *A textbook on apiculture.* Saras Publications.
11	Agritech Portal, Tamil Nadu Agricultural University (TNAU). (n.d.). *Apiculture – Harvesting and processing.* https://agritech.tnau.ac.in/farm_enterprises/fe_api_harvestingandprocessing.html
12	Bee Culture Magazine. (n.d.). *Beeculture – The magazine of American beekeeping.* https://beeculture.com/
13	Food and Agriculture Organization (FAO). (n.d.). *Pollination services for sustainable agriculture* [PDF]. https://www.fao.org/3/i0374e/i0374e.pdf
14	Jiwaji University. (n.d.). *Melissopalynology (PDF).* https://www.jiwaji.edu/pdf/ecourse/botany/Melissopalynology.pdf
14	KAU Agri-Infotech Portal. (n.d.). *Apiculture.* https://www.celkau.in/Agrienterprises/Apiculture.aspx
15	Kerala Agricultural University (KAU). (n.d.). *Honey supplying and bee colony providing unit.* https://kau.in/honey-supplying-and-bee-colony-providing-unit
16	Khadi and Village Industries Commission (KVIC). (n.d.). *Introduction to beekeeping – CBRT.* https://www.kvic.gov.in/kvicres/newhm/cbrtintro.html
17	Khadi and Village Industries Commission (KVIC). (n.d.). *Common project profile – Honey bee farming (PMEGP).* https://www.kviconline.gov.in/pmegp/pmegpweb/docs/commonprojectprofile/HoneyBeeFarming.pdf
18	Media House Online. (n.d.). *How to start up a beekeeping business.* https://www.mediahouse.online/product/how-to-start-up-beekeeping-business/
19	National Bee Board (Department of Agriculture & Farmers Welfare). (n.d.). *Home page.* https://nbb.gov.in/
20	State Horticulture Mission Kerala. (n.d.). *National Beekeeping and Honey Mission (Madhukranti Portal).* https://shm.kerala.gov.in/national-beekeeping-and-honey-mission-madhukranti-portal-registration/
21	The Integrated Environmental Solutions Trust (TIES). (n.d.). *Capacity building in apiculture.* https://www.ties.org.in/CapacityBuilding/7

22	YouTube. (2019). *KVIC – Beekeeping Training Video #1.* https://www.youtube.com/watch?v=_J3NrOrOR3o
23	YouTube. (2020). *KVIC – Beekeeping Training Video #2.* https://www.youtube.com/watch?v=jeFxOUZreXI

TEACHING LEARNING STRATEGIES	MODE OF TRANSACTION
➢ Collaborative learning-Group discussion ➢ Documentaries ➢ Filed visits and demonstrations	➢ Lecturing ➢ ICT ➢ Practical sessions with demonstrations and hands on experiences

ASSESSMENT RUBRICS	Marks
End Semester Evaluation ESE	
• University Examination	50
Continuous Comprehensive Assessment CCA	
• Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)	10
• Writing assignment	5
• Reports/ presentations/ demonstrations by the students	10

Employability for the Course / Programme

Students will get orientation on how to set up apiculture facilities and also for their value addition.