SCHEME AND CREDIT DISTRIBUTION CHART OF COURSES IN THE M.Sc. BOTANY PROGRAMME

SEM	COURSE WITH CODE		MARKS			CREDIT	Hours/week	
			Internal	External	Total		L	P
I	MSBOT01 C01	GENERAL AND APPLIED MICROBIOLOGY	15	60	75	4	4	2
	MSBOT01 C02	PHYCOLOGY, MYCOLOGY AND PLANT PATHOLOGY	15	60	75	4	4	3
	MSBOT01 C03	BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS	15	60	75	4	4	3
	MSBOT01 C04	RESEARCH METHODOLOGY, INSTRUMENTATION AND BIOSTATISTICS	15	60	75	4	3	2
	MSBOT01 C05	PRACTICAL PAPER -1	12	48	60	4		
	RECORD+SUBMISSION		3	12 (6+6)	15			
TOTAL FOR FIRST SEMESTER			**75**	**300**	**375**	**20**	**15**	**10**
II	MSBOT02 C06	PALEOBOTANY, PALYNOLOGY AND EVOLUTION	15	60	75	4	3	2
	MSBOT02 C07	ANGIOSPERM ANATOMY, EMBRYOLOGY AND MICROTECHNIQUE	15	60	75	4	4	3
	MSBOT02 C08	GENETICS AND CROP IMPROVEMENT	15	60	75	4	4	2
	MSBOT02 C09	PLANT PHYSIOLOGY AND BIOCHEMISTRY	15	60	75	4	4	3
	MSBOT02 C10	PRACTICAL PAPER -2	12	48	60	4		
	RECORD+SLIDES		3	12 (6+6)	15			
TOTAL FOR SECOND SEMESTER			**75**	**300**	**375**	**20**	**15**	**10**
III	MSBOT03 C11	ENVIRONMENTAL SCIENCE	15	60	75	4	4	2
	MSBOT03 C12	ANGIOSPERM SYSTEMATICS	15	60	75	4	4	4
	MSBOT03 C13	GENETIC ENGINEERING, PLANT BIOTECHNOLOGY AND BIOINFORMATICS	15	60	75	4	4	2
	MSBOT03 O01/02/03/04/05/06/ 07/08	OPEN ELECTIVE (Multi-Disciplinary)	15	60	75	4	3	2
	MSBOT03 C14	PRACTICAL PAPER -3	12	48	60	4		
	RECORD+HERBARIUM		3	12 (6+6)	15			
TOTAL FOR THIRD SEMESTER			**75**	**300**	**375**	**20**	**15**	**10**
IV	MSBOT04 C15	CELL AND MOLECULAR BIOLOGY	15	60	75	4	4	3
	MSBOT04 E01/02/03/04	ELECTIVE	15	60	75	4	4	2
	MSBOT04 E05/06/07/08	ELECTIVE	15	60	75	4	4	2
	MSBOT04 C16	PROJECT, FIELD STUDY AND INSTITUTE VISIT	15	60 (40+10+10)	75	4		6
	MSBOT04 C17	PRACTICAL PAPER -4	12	48	60	4		
	RECORD+MOOC COURSE		3	12 (6+6)	15			
TOTAL FOR FOURTH SEMESTER			**75**	**300**	**375**	**20**	**12**	**13**
TOTAL			**300**	**1200**	**1500**	**80**		

SEMESTER III

CORE COURSES

MSBOT03 C11 ENVIRONMENTAL SCIENCE

Course Objectives

The main objectives of this course are to promote environmental awareness, encouraging environmentally responsible behaviour, and developing an environmentally ethic behaviour that promotes an understanding of the ecological interdependence of the social, political and economic spheres. The course also focusses to acquire the knowledge, values, attitudes and practical skills to participate in a responsible and effective way in anticipating and solving social problems, and in the management of the quality of the environment. The course also aims to make the students apply their knowledge for efficient environmental decision-making, management and sustainable development.

Theory (72 Hours)

MODULE I: Basics of Environment (22 Hours)

Concepts in Ecology: Autecology; population ecology, characteristics of populations, size and density, dispersion, age structure, natality and mortality. Population growth, factors affecting population growth, environmental resistance, biotic potential, carrying capacity, positive and negative interaction, migration and subsistence density. Genecology: Ecological amplitude, ecads, ecotypes, ecospecies and coenospecies. Synecology: Community ecology, ecological processes of community formation, ecotone and edge effect. Classification of communities: criteria of classification, dynamic system of classification by Clement. Special plant communities: quantitative, qualitative and synthetic characteristics of plant communities, coefficient of communities; Sorenson's Index of similarity.

Atmospheric and water chemistry: Chemical reactions in the atmosphere, aerosol types, production and distribution; aerosols and radiation; atmospheric turbidity and related environmental problems, inversions, global climate and photochemical reactions. Particles in atmosphere: Composition, sources, types and effects. Water chemistry: Water pollutants – types, sources, heavy metals, metalloids, organic, inorganic, microplastics, biological and radioactive; types of reactions in various water bodies including marine environment; eutrophication; ground water, potable water.

Module II: Environmental Management and Sustainable Development (14 Hours)

Humanity-environment relationship: population growth, problems; rational use of resources; objectives of environmental education, guiding principles, UNESCO 1977 recommendations, environmental programmes; environmental education in India. Environmental organizations and agencies: international bodies, MAB, government and nongovernment (voluntary) organizations; environmental administrative control, central and state pollution control boards; Department of Environment and Forests; special technologies. Sustainable development: definition, scope and importance; causes of un-sustainability, ecological footprints, guidelines for sustainable development and reduction of poverty; agricultural sustainability.

Module III: Solid Waste Management (20 Hours)

Sources and generation of solid waste, characterization, chemical composition and classification. Dumping of garbage: Commercial, industrial, agriculture, mining and power plant discharges. Disposal Methods: composting, incineration and others. Biomedical waste management. Hazardous Waste Management: Cyanides, dioxins, detergents, plastics, nylon, PCB's and others. Waste minimization methods; monitoring and management strategies; chemical and disaster management and risk analysis. Degradation of pesticides, detergents, plastics and polymers.

Environmental audit and economics: Objectives, scope; energy audit, green audit and water audit; organization and staffing of audit team; resources. Approach to audit: (a) Pre-visit activity; (b) On-site activities: understanding management systems, assessing strengths and weaknesses, audit evidence gathering and evaluation; (c) Post Audit Activities: audit principles, benefits to industry. Environmental Economics: concepts of economics and scope of Environmental Economics; economics of pollution control, cost-benefit analysis and evaluation.

Module IV (Self study) (16 Hours)

Conservation Biology: Conservation and management of biodiversity; types of conservation, *in-situ* and *ex-situ* conservation, concept of germ plasm preservation and gene banks; People's Biodiversity Registers and their importance, National Biodiversity Strategy and Action Plan Programme, Protected Area Management Plan, Biological Diversity Act 2002, Patent Act, Agenda 21; National Policies and Acts [Wild Life (Protection) Act,1972] related to biodiversity; man animal conflicts.

Pollution Ecology: Types of pollutants, concept of pollutant and waste; noise, radioactivity, temperature, light and electromagnetic waves as pollutants. Effects of pollution on ecosystem, biodiversity and health issues related to man and other organisms. Global warming, greenhouse effect, ozone depletion, acid rain, *El-Nino*, *La-Nina*, ENSO. Prevention methods to control pollution: bioremediation, phytoremediation, bioaugmentation, biofilms, biofilters, bio scrubbers and trickling filters.

Practical (36 Hours)

1. Estimation of a primary productivity in a water body.
2. Estimation of alkalinity, hardness and chlorides in water sample.
3. Determination of soil type and texture, pH, conductivity, soil moisture content and organic carbon.
4. Conduct a case study and submit report of any environmental issue in the local area based on self-study module.
5. Visit to a specialised ecosystem and submit a report.
6. Conduct vegetation analysis and calculate IVI by quadrat or line transect method.

References

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8. Mac Arthur R.H. 1972. Geographical Ecology: Patterns in the Distribution of Species, Harper & Row Publications, New York.
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12. Seshadri, B. 1982. Indian Wild Life Resources, Sterling Publishers, New Delhi.
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14. Stracey, P.D. 1963. Wild Life in India – Its Conservation and Control, Ministry of Food and Agriculture, Govt. of India, New Delhi.
15. Tyler Miller Jr, G. 1996. Living in the Environment– Principles, Connections and Solutions, Wadsworth Publishing Co., New York.

MSBOT03 C12 ANGIOSPERM SYSTEMATICS

Course Objectives

The main objectives of this course are to understand and practice the basic principles and procedures in the flowering plant systematics; establish a relation between the geography of a region and its floristic diversity and to develop practical skills for identifying the local flora, sketching scientific illustrations, and preparing herbaria. On the successful completion of the course, students will be able to systematically identify, name and classify flowering plants and construct artificial keys for the identification of flowering plants of a flora. They will also be able to distinguish taxonomic categories of a flowering plant specimen by analyzing its diagnostic characters and appraise the evolutionary status and phytogeographic distribution of a taxon by evaluating correlated characters. On completion of the course, the students will be able to describe new flowering plant taxa.

Module I (15 Hours)

Objectives, scope and importance of taxonomy. Major centres of taxonomy in the world and India. A critical study of the current ideas of the origin of Angiosperms with special reference to their ancestral stocks and time of origin. The recent concepts on primitive angiosperms. Fossil angiosperms.

Historical development of theories and concepts of plant classification and classificatory systems. Detailed study of classification proposed by Bentham and Hooker. Evolution of APG system of classification with a detailed account on APG IV. Historical development of plant taxonomy in India with special reference to the contribution by William Roxburgh, J.D. Hooker, J.S. Gamble and K.S. Manilal.

Taxonomic structure: taxon, taxonomic category and taxonomic rank. Taxonomic hierarchy; major and minor categories used in taxonomy. Concept of species, genus and family; supraspecific categories and infraspecific categories; cladistics, cladogram and Adansonian Principles.

Module II (15 hours)

Methods of Plant exploration and identification. Taxonomic literature: Floras, Manuals, Revisions, Monographs, taxonomic journals. taxonomic databases; e-Floras. taxonomic keys: intended and bracketed. Botanical Survey of India. History of botanical exploration in India and recent works with special emphasis on Kerala.

Plant nomenclature: Brief history on the origin and development of botanical nomenclature; detailed study of the major provisions of the International Code of Nomenclature for Algae, Fungi and Plants (ICN); Effective and valid publication, ranks of taxa, rule of priority and its limitations; typification, author citation, rejection and retention of names, conserved names; valid and invalid names, *nomen nudum*, conserved names. Names of hybrids; nomenclature of cultivated plants.

Taxonomic character, character variations and their taxonomic implications; concept of primitive and advanced characters. Sources of taxonomic characters: Morphology, anatomy, palynology, cytology, phytochemistry and embryology. Modern trends in taxonomy: Cytotaxonomy, chemotaxonomy, biosystematics and numerical taxonomy.

Principles and procedure of phylogenetic systematics, classification of tree building methods: Maximum Likelihood and Bayesian analysis. Cladogram analysis. Brief account of DNA bar coding in plants.

Module III (30 Hours)

Method of describing a plant species using morphological characters. Familiarization of technical terms associated with the following: habit, habitat; root, stem, leaf, inflorescence; bract and bracteoles, flowers, fruits and seeds.

Study of the following families with special reference to their phylogenetic relationship and economic importance: Ranunculaceae, Magnoliaceae, Menispermaceae, Brassicaceae, Polygalaceae, Caryophyllaceae, Clusiaceae, Capparidaceae, Sterculiaceae, Geraniaceae (Oxalidaceae and Balsaminaceae), Sapindaceae, Rhizophoraceae, Melastomaceae, Passifloraceae, Aizoaceae, Gentianaceae, Boraginaceae, Convolvulaceae, Oleaceae, Lentibulariaceae, Bignoniaceae, Scrophulariaceae, Pedaliaceae, Lauraceae, Loranthaceae, Amaryllidaceae, Commelinaceae, Araceae, Cyperaceae.

Module IV (Self study) (12 Hours)

General concepts of morphology: Origin and evolution of flower; coevolution of flowers *viz-a-viz* pollinators. Stamens: origin and evolution in structure and morphology. Morphology of Nectaries. Evolution of carpels: Different types of carpels, concepts of foliar origin of carpels. Evolutionary trends in pollination mechanisms.

Expression of relationship: monophyly, polyphyly, homology, analogy, parallelism, divergence, convergence. Plant speciation: Allopatric, sympatric, abrupt, hybrid, apomictic

speciation; isolation mechanisms.

Herbarium methods: Wet and dry preservations, virtual herbaria, functions of herbarium; major herbaria in the world and India. Importance of botanical gardens; role in taxonomy and biodiversity conservation.

Practical (72 Hours)

1. During the course of study, the students shall get familiar with local flora, construction of keys, use of floras for the identification up to the species level.
2. Study of the diagnostic features of the families included in the syllabus (Plants not included in the Flora of the Presidency of Madras are not expected to be given for practical examination).
3. Work out 2 species each (at least one) from the families mentioned in the syllabus, draw line diagrams, describe in technical terms and identify by constructing a key up to species level.
4. Each student shall undertake a field study for at least five days under the guidance and supervision of the teacher at a place ecologically different from the respective college and submit a field study report certified by the concerned teacher.
5. Each student shall submit at least 25 herbarium sheets of different families (need not be from the families mentioned in the syllabus) along with field note book for practical examination.
6. Each student shall solve nomenclatural problems involving the identification of legitimate name, invalid names, basionyms and synonyms and must be familiar with common terminologies in botanical citations.
7. Construction of a phylogenetic tree using any online software available free of cost.
8. Dissection of flower for the identification of primitive flower (*Clematis, Magnolia, Nymphaea, Nelumbium*), transitional stamens (*Nymphaea, Nelumbium*) and their evolution.

References

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2. Barnard, C. 1961. The Interpretations of Angiosperm Flower. *Australian Journal of Sci*ence 24: 6664-72.

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MSBOT03 C13 GENETIC ENGINEERING, PLANT BIOTECHNOLOGY AND BIOINFORMATICS

Course Objectives

The main objective of the course is to provide an overview of genetic engineering and plant biotechnology. Students will learn the basic principles of this applied branch of science. They will be introduced to different techniques and aspects of biotechnology that will make them aware of the scope of the subject. Students will learn the different techniques of plant biotechnology, especially the plant tissue culture. They will also learn the overall purpose and strategy for the construction of recombinant DNA and they will also learn how bioinformatics supplement such studies.

Module I: Introduction to Genetic engineering (18 Hours)

Unit 1: Gene cloning and expression strategies (restriction and gateway cloning), screening and selection of recombinants. Cloning interacting genes (yeast two hybrid and three hybrid system). Vector construction (binary and Shuttle vector), transformation methods, transformation procedures and selection strategies.

Brief account of applications and achievements of genetic engineering in agriculture (herbicide resistance, insect resistance, virus resistance, Flavr Savr tomato, barnase and barstar, transgenic plants for molecular farming, BT Cotton, Golden Rice, antisense RNA technology, VIGS); medicine (RNAi, CRISPR-Cas9), food (Single cell proteins, Nutraceuticals, Mycoproteins) and industry (enzyme biotechnology, biosensors, biochips).

Unit 2: Basics of gene Amplification, cloning and PCR methods, variants of PCR and their applications. DNA Finger Printing techniques: Hybridization based and PCR based techniques (various types and applications). Marker assisted selection and crop improvement. GMO versus non-GMO techniques for crop improvement (mutation breeding, gene editing, tissue culture, hybridization, polyploidy breeding – general account only). Blotting techniques (Southern, Northern and Western). Ethical and environmental considerations of GMOs.

Module II: *In vitro* techniques of Plant propagation and transformation (18 Hours)

Unit 1: Organogenesis and somatic embryogenesis: techniques and applications. Protoplast Culture: protoplast isolation, regeneration and viability test, somatic hybridization and methods of protoplast fusion, chemical, viral, electro fusion. practical application of somatic

hybridization and cybridization, production of synthetic seeds, importance, limitation and their utilization. Isolation of somaclonal variants, molecular basis of somaclonal variation. Origin of somaclonal variation - pre-existing variability, in vitro induced variability; reasons – changes in ploidy level, changes in chromosome structure, gene mutations, gene amplifications, changes in extra nuclear genes, activation of transposable elements, DNA methylation. Applications of somaclonal variation.

Unit 2: Methods of gene transfer in plants. Agrobacterium and virus mediated gene transfer; direct gene transfer using PEG, micro injection, electroporation, microprojectile (biolistics) method, liposome mediated DNA delivery. Transposable elements as vectors.

Module III (18 Hours)

Basics in Bioinformatics: Types of Biological data: Biodiversity data, molecular data - DNA, RNA and Protein sequences. Genomes and proteomes. Eukaryotic genome with special references to model organisms: Yeast, *Arabidopsis thaliana* and Rice.

Bioinformatic Resources: NCBI, EBI, ExPASy, RCSB. Nucleotide sequence Databases: GenBank, EMBL, DDBJ; Protein sequences Databases: Swiss-Prot, TrEMBL, UniProt, UniProtKB, UniParc, UniRef, UniMES; Sequence motifs Databases: Prosite, ProDom, Pfam, InterPro, Gene Ontology; Sequence file formats: GenBank, FASTA, PIR, ALN/ClustalW2. Patent databases, TAIR, PDB, ATIDB, OMIM; Medical databases, KEGG, EST databases, Chemical Databases: ZINC, Pubchem, Chembl.

Module IV (Self study) (18 Hours)

Basic concepts of Genetic Engineering. Recombinant DNA technology, enzymes and vectors for gene cloning. Brief account on laboratory instructions and maintenance of sterilization, composition of media, nutrient and hormone requirement; morphogenesis and organogenesis -mode of action of auxin and cytokinin. Organ culture: Anther, Pollen, Embryo and Endosperm culture, Hairy Root Culture and their applications.

Applications of tissue culture: Applications of tissue culture in forestry, agriculture and medicine. Edible vaccines and their prospects. Production of secondary metabolites: culture conditions for producing secondary metabolites, selection of high yielding lines, elicitation and immobilization of cells. Hairy root culture: advantages of using hairy root culture, establishment of hairy root culture and production of secondary metabolites. General account of plant biotechnology institutes and industry in India and Kerala.

Practical (36 Hours)

1. Preparation of plant tissue culture media and stock solutions, and their sterilization (example: Murashige and Skoog medium).
2. Demonstration of *In vitro* culture of plants.
3. Preparation of synthetic seeds with excised/somatic embryo.
4. Demonstration of PCR.
5. Demonstration of bacterial transformation (Blue-white selection).
6. Multiple sequence alignment.
7. Phylogenetic analysis of gene families.
8. Visit to a biotechnology laboratory.

References

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OPEN ELECTIVE COURSES
(Multi-Disciplinary)

A student shall select any one course of the courses offered by the Department from the bunch of eight courses, MSBOT03 O01 to MSBOT03 O08.

MSBOT03 O01 SPECTROSCOPY AND PROTEIN STRUCTRE PREDICTION

Course Objectives

The main objectives of this course are to analyse the primary, secondary, tertiary, and quaternary structures of proteins and their functions; to explore protein engineering and design methods for various biotechnological and medical purposes; to compare and contrast biological and recombinant protein synthesis processes; to utilize molecular graphics for the analysis of protein structure; and to explore protein bioinformatics tools and methods for sequence and structural analysis.

Theory (54 Hours)

Module I (18 Hours)

Introduction to Spectroscopy: basic principles of spectroscopy, electromagnetic spectrum and its significance, interaction of light with matter: absorption, emission and scattering. Types of spectroscopy and their applications. Introduction to UV-Visible Spectroscopy, Beer-Lambert Law and its applications, instrumentation, applications in chemistry, biology, and environmental science. Introduction to IR spectroscopy, vibrational transitions and molecular vibrations, modes of vibration and selection rules, instrumentation and sample preparation, interpretation of IR spectra and applications. Introduction to Nuclear Magnetic Resonance (NMR) spectroscopy, nuclear spin and magnetic resonance, chemical shift, coupling and relaxation, NMR instrumentation and data interpretation, applications in organic and inorganic chemistry, biochemistry, and medicine. Other spectroscopic techniques (brief account only): Fluorescence spectroscopy, Raman spectroscopy, X-ray spectroscopy and Mass spectrometry.

Module II (8 Hours)

Introduction to Protein Structure: Protein structure hierarchy, amino acids, peptide bonds,

protein function and structure-function relationships. Protein folding**:** Primary, secondary, tertiary and quaternary protein structures, thermodynamics of protein folding, secondary structure elements (α-helix, β-sheet), forces stabilizing protein structures, chaperone proteins and their role in protein folding,

Module III (16 Hours)

Structural databases and tools: PDB (Protein Data Bank) and other structural databases, Software tools for protein structure analysis, visualization and analysis of protein structures. Protein structure prediction: Homology modelling, Ab initio protein structure prediction, CASP (Critical Assessment of Structure Prediction). Analysis of protein structure using molecular graphics. Introduction to databases for protein sequences, structures and functions. Protein bioinformatics tools and methods. Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, PIR-PSD, Protein-Protein interaction database: STRING.

Module IV (12 Hours)

Enzyme structure and catalysis, protein-ligand interactions, signalling proteins and their role in cell communications, structural basis of membrane proteins. Protein structure in drug discovery: drug design and target identification, antibody engineering, protein engineering and design. Recent advances and emerging trends: Recent breakthroughs in protein structure determination, structural genomics and proteomics, emerging technologies and biotechnological applications of protein structure. Use of proteins in biotechnological, medical research and development. Importance of proteins in the development of different types of drugs. Antibody engineering, Protein engineering and design.

Practical (36 Hours)

1. Exploring NCBI and UniProt databases.
2. Software for viewing protein structures.
3. Protein Phylogenetic analysis using software tools.
4. Exploring protein interactions using STRING.

References

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2. Branden, C. I. & Tooze, J. 2012. *Introduction to protein structure*. Garland Science.
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7. Mount, D. 2004. Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York.
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MSBOT03 O02 BASIC AGRICULTURAL PRACTICES

Course Objectives

The main objectives of this course are to understand the scope of agronomy and its interdisciplinary relationship with other sciences; to evaluate the components of farming systems and their maintenance for sustainable production; to familiarize the benefits and challenges of organic farming practices in modern agriculture; and to understand herbicide resistance in weeds and strategies for its management in agricultural systems.

Theory (54 Hours)

Module I (12 Hours)

Basics of Agronomy: Scope and relationship with other sciences, Tillage and tilth, seeds and sowing. Modern versus traditional agriculture; crop nutrition, manures and fertilizers. Nutrient use efficiency. Plant ideotypes. Crop rotation and its principles. Harvesting, threshing and storage of field crops and seeds.

Module II (18 Hours)

Farming Systems and Sustainable Agriculture: Scope, importance and concept; types and systems of farming, factors affecting types of farming and their maintenance; cropping system and pattern, multiple cropping system, efficient cropping system and their evaluation. Sustainable agriculture: methods, precision farming, intercropping, problems and its impact on agriculture. Role of water and energy conservation, indicators of sustainability, adaptation and mitigation; conservation strategies in agriculture.

Module III (12 Hours)

Organic farming: History of organic farming in India; principles and its scope. Initiatives taken by government (central/state), NGOs and other organizations for promotion of organic agriculture; organic ecosystem and their concepts; organic nutrient resources and their fortification; certification process and standards of organic farming.

Module IV (12 Hours)

Weed Management: Introduction to weeds, characteristics of weeds and their harmful and beneficial effects on ecosystem. Classification, reproduction and dissemination of weeds. Herbicide classification, herbicide formulation and their use. Allelopathy and its application for weed management. Bio-herbicides and their application in agriculture. Herbicide

resistance and its management.

Practical (36 Hours)

1. Study of farming systems (2 types) and their components.
2. Case study of common water and energy conserving technologies used in agriculture.
3. Identification of different tillage implements.
4. Identification and critical study of fertilizers and pesticides used in organic farming.
5. Identification of weed flora in different field crops.
6. Prepare and submit a case study report of an organic farmer.

References

1. Singh, C. 1983. Modern techniques of raising field corps. Oxford and IBH Publishing Co. Ltd., Bangalore.
2. Dahama, A.K. 2018. Organic Farming for Sustainable Agriculture. Agrobios Publication.
3. Gopal Chandra, De. 1980. Fundamentals of Agronomy. Oxford and IBH Publishing Co. Ltd., Bangalore.
4. Gupta, O.P. 2008. Modern Weed Management, Agribios India Publication.
5. ICAR 2011. Hand book of Agriculture, ICAR Publication.
6. Panda, S.C. 2006. Agronomy Agribios Publication, New Delhi.
7. Rao, V.S. 2006. Principles of Weed Science. Oxford and IBH Publishing Co., New Delhi, India.

MSBOT03 O03 ENVIRONMENTAL MANAGEMENT

Course Objectives

The main objectives of this course are to grasp a comprehensive understanding of environmental management; to foster a sense of responsibility towards environmental conservation and sustainability; to explore different pollution control techniques and technologies; to familiarize key government agencies, programs, and regulatory bodies responsible for environmental protection and management; to familiarize good manufacturing practices and laboratory management practices to minimize environmental impacts and ensure sustainable operations.

Theory (54 Hours)

Module I: Environmental Management (8 Hours)

Concept, importance and perspectives of environmental management in India. The Environment (Protection) Act 1986; National Environmental Policy 2006; environmental priorities in India. Principles of management: Design and structure of an organization; managerial functions, roles and skills; planning processes; problem solving and decision making; control mechanisms; management of conflict and coping with stress.

Module II: Pollution (20 Hours)

Water Pollution: Sources, nature and impacts; eutrophication - concept, cause and effects; ocean pollution; ground water pollution; river pollution; Ganga Action Plan (GAP), Yamuna Action Plan (YAP); water pollution control; water pollution monitoring; water quality standards; The Water (Prevention and Control of Pollution) Act 1974; case studies.

Air pollution: Source, nature and impacts; effects of acid rain; vehicular air pollution; status of air pollution in major Indian cities; air quality monitoring and air quality standard; control techniques and management issues; The Air (Prevention and Control of Pollution) Act 1981; Green belts. Indoor Pollution: Pollutants at homes and work places; allergens; environmental hazards in science laboratories; lifestyle hazards; control and management strategies.

Module III: Solid Waste Management (14 Hours)

Solid waste: Concept, sources, quality and quantity; economic importance, characterization; conventional methods and design of collection, transport, treatment and disposal, environmental hazards of disposal; reuse, recycling and recovery of materials and resources;

composting and vermi-composting; management of plastic wastes; integrated management of wastes; Municipal Solid Wastes (Management and Handling) Rules 2000. Government agencies and programs: NCEPC, MoEFCC, CPCB and SPCB's.

Module IV: Environmental Management Tools (12 Hours)

Fundamentals of pollution prevention and environmental assessment; Environmental Impact Assessment (EIA), Environmental Risk Assessment, Environmental Management Plan (EMP), pollution prevention, green technologies. Environmental Audits: International Organization for Standardization (ISO): ISO 14001, explanation of ISO 14000 series; Clause analysis of ISO 14001, explanation of PDCA cycle; environmental auditing; certification process; comparison of ISO 9001 and ISO 14001; Comparison of ISO 14001 and OHSAS-18001.

Practical (36 Hours)

1. Case study and submission of report of pollution and waste management of an urban area.
2. Analysis of different water quality parameters (temperature, pH, turbidity, free carbon dioxide, alkalinity, dissolved oxygen) in different water systems.
3. Assessment of nutrient levels (nitrate, orthophosphate) of water bodies for management.

References

1. Barrow, C. 2006. *Environmental management for sustainable development*. Routledge.
2. Buchholz, R.A. 1998. *Principles of environmental management: the greening of business* (No. Ed. 2). Prentice-Hall Inc.
3. Dash, M.C. 2019. Concepts of Environmental Management for Sustainable Development. Dreamtech Press.
4. Louis T. and M.K. Theodorei 2021. *Introduction to Environmental Management*, CRC Press.
5. Saxena, H.M. 2000. Environmental Management. Rawat Publications.
6. Uberoi, N.K. 2003. *Environmental management*. Excel Books, India.

MSBOT03 O04 ORNAMENTAL HORTICULTURE

Course Objectives

The main objectives of this course are to make the students aware of the importance of horticulture, its branches and landscaping; to impart knowledge about the important gardens in the world and the types of gardens; to inculcate knowledge about essential garden tools, implements and plant growing structures; to attain knowledge about garden practices and the usage of fertilizers and soil conditioners and to give an awareness to students regarding the common diseases and pests of gardenplants.

Theory (54 Hours)

Module I (10 Hours)

Introduction: Concept, scope and importance of horticulture: as an art, science and business. Branches of horticulture; opportunities in horticulture. Famous gardens in the world and in India; types of gardens based on country of origin. Basic styles of gardens: formal, informal and wild gardens.

Developing the landscape: Plan (general), components and features of landscaping: plant components (lawn, shrubbery, flower beds and borders, rockery, carpet beds, topiary, hedges); choosing shade and avenue trees; selecting hedges and shrubs for the garden; non plant components (garden adornments, arches, pergolas, trellises, garden walls, gates, garden fences, footpaths, seats, tables, garden houses, etc.).

Module II (14 Hours)

Special type of gardens: Botanical and ornamental gardens; butterfly garden, herbal garden, kitchen garden, rock garden, roof garden, sensory garden, vertical garden, water garden, container garden, sunken garden, vertical garden, terrariums and bottle gardens. Plant growing structures: Shade house, green house, poly house, glasshouse, mist chamber/mist beds, hot beds, lath houses.

Garden tools and equipment: Different types of cutting tools: Shears - long handled, short handled, lawn shears, secateurs, sickles, wheel barrow, rake, fork, spade, watering cans, lawn mower (electric and petrol mower), grass cutters and sprayers.

Bonsai: For indoors and outdoors - how to make and how to care, pruning and shaping, different types of containers for bonsai.

Lawn: How to make and maintain lawn - preparation of soil, selecting lawn grass, planting methods, caring for the lawn (watering fertilizer application, mowing) control of weeds, insects and diseases.

Module III (14 Hours)

Planting: Pre-planting, planting and post-planting cultural practices; cultural practices to increase productivity: thinning, training, trimming and pruning; plant propagation practices: seed propagation and vegetative propagation - natural and artificial. Artificial methods of vegetative propagation: cuttage, layerage, graftage, budding, micropropagation. Rooting hormones.

Common border, boundary and screen plants: How to select, method of propagation, preparation of pits and manuring.

Fertilizers and Pest Control: Organic fertilizers - biofertilizers, compost, vermicompost, agricultural waste, livestock manure, municipal sludge. Inorganic fertilizers: NPK fertilizers; natural and synthetic soil conditioners and soil ameliorants. Common diseases and pests of garden plants, symptoms and causative agents; integrated pest management, physical and biological control, push-pull technology.

Module IV (16 Hours)

Common ornamental trees (*Delonix, Peltophorum, Senna siamea, Cassia fistula, Albizia lebbeck, Spathodea, Thespesia, Callistemon, Casuarina, Polyalthia, Bauhinia, Pongamia*); shrubs (*Calliandra, Ixora, Allamanda, Hibiscus, Euphorbia,* Crotons*, Dracaena, Galphimia*); and climbers (Morning glories, *Clitorea, Thunbergia, Bignonia, Venonia* (Curtain plant). Flowering plants: annual flowering plants (*Petunia, Dianthus*, Marigold, *Gomphrena, Zinnia, Dahlia, Catharanthus*) - soil requirements, sun light, how to grow, where to plant, how to care. Foliage plants for indoors and outdoors: how to grow foliage seedlings, common garden Aroids, Marantas, Calatheas, Dracaenas and ferns. Others: Anthurium, Cacti, succulents, bromeliads and Orchids.

Floral arrangement: Principles, basic elements, shapes, types and styles of flower arrangements, flowers and foliage suitable for flower arrangements.

Practical (36 Hours)

1. Identify common ornamental trees, climbers, shrubs, and flowering plants of garden origin.
2. Establish, maintain and record terrarium/bottle garden.

3. Design a garden for small landscape (terrace/balcony/courtyard) and record.
4. Visit one of the major gardens nearby and submit a report.
5. Identify various garden tools and implements.
6. Preparation of floral/foliage arrangements/bouquet.

References

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2. Adams, C., Early, M., Brook, J. and Bamford, K. 2015. Principles of Horticulture, Taylor & Francis Ltd, UK.
3. Chadha, K. L. 2019. Handbook of Horticulture, Indian Council of Agricultural Research, New Delhi.
4. Charles Griner. 2005. Floriculture- Designing and Merchandising, Delmar Publishers, An International Thomson Publishing Company.
5. Dixon, G.R. and Aldous, D. E. 2014. Horticulture: Plants for People and Places, Springer.
6. Kathy, F. 2015. Manual of Interior Plant scaping, Timber Press, Portland, Oregon.

MSBOT03 O05 BIODIVERSITY AND CONSERVATION

Course Objectives

The main objectives of this course are to understand the concept and components of biodiversity, its significance and values, various threats and strategies adopted for their conservation. The student will familiarize the RED Data Book and IUCN Red list categories. The student will attain skill in process of red listing of plants based on the latest IUCN criteria.

Theory (54 Hours)

Module I (12 Hours)

Biodiversity: Definition; levels of biodiversity, genetic diversity, species diversity, ecosystems diversity; alpha, beta and gamma diversity; global and Indian scenario; megadiversity nations and hotspots; Biosphere Reserves; Biodiversity Hotspots, Biodiversity hot spots of India. Values of biodiversity. Threats to biodiversity; Red data book; exotic and indigenous plant species; keystone species, flagship species. Endemism and endemic species. Threatened species.

Module II (22 Hours)

Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy: Conservation Projects, Sanctuaries, National Parks and Biosphere reserves. What to conserve; why to conserve; overview of genetic variability: population biology of endangered species, conservation genetics, wildlife biology.

Conservation and management of biodiversity: Indian forest conservation act, Biological Diversity Act (2002). Role of ethnic groups in conservation of plant genetic resources. Threatened taxa and forest management (participatory forest management). Organizations: IUCN, UNEP and WWF; NBPGR, Kerala State Biodiversity Board (KSBB), National Biodiversity Authority (NBA).

Module III (12 Hours)

In-situ conservation: Assessment of adequate areas, design and management of protected areas; problems in protected areas of India, connectivity and corridors, sustainable use of biodiversity, conservation and society, conservation networks. Biosphere reserves, National parks, Sanctuaries, Sacred grooves, wetlands and mangroves.

Ex-situ conservation: Facilities, establishment of new populations, captive breeding, reintroduction, discussion of advantages and disadvantages. Concept of germ plasm preservation and gene banks. Botanical gardens, field gene banks, seed banks, cryo-banks, pollen banks, culture-collections.

Module IV (8 Hours)

Introduction to IUCN: Historical background of IUCN; RED Data Book, IUCN Red List, IUCN Red List categories. Detailed study of IUCN criteria and assessment process. Supporting information for Red List assessments. National Red Lists.

Practical (36 Hours)

1. Assessment of species listed in IUCN categories and their present distribution.
2. Conservation of red listed species by raising seedlings and planting in the field.
3. Visit a nearby forest area/sacred grove/laterite/wetland ecosystem and identify IUCN red listed species.
4. Assessment of species distribution, their density and abundance using quadrats, line transects or waypoints.
5. Visit a seed bank or gene bank and record the methods of conservation followed.

References

1. Singh, J.S., Singh, S.P., Gupta, S. 2006. Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
2. Dobson A.P. 1996. Conservation and Biodiversity, Scientific American L ibrary, New York.
3. Groom bridge B., and M. Jenkins 2000. Global Biodiversity: Earth's Living Resourcesin the 21st Century, World Conservation Press, Cambridge, UK.
4. Harvey D. 2000. Climate and Global Climate Change, Prentice Hall Inter-Governmental Panel of Climate Change (IPCC) Reports.
5. IUCN 2004. Red list of threatened species - a global species assessment, IUCN, Gland, Switzerland.
6. Klee G. A. 1991. Conservation of natural resources, Prentice Hall.
7. Loreau M., and P. Inchausti 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives, Oxford University Press, Oxford.
8. Primack R.B. 2002. Essentials of Conservation Biology (3rd Edition), Sinauer Associates, Sunderland, SA.
9. https://www.iucnredlist.org/assessment/process

MSBOT03 O06 MARINE BOTANY

Course Objectives

This course aims to develop a basic knowledge in the components of marine ecosystems including mangroves. The students will get an overall understanding on the floristic diversity and ecology of marine ecosystems. They will apply the knowledge gained in tackling the problems related with the pollution of marine ecosystems.

Theory (54 Hours)

Module I: Marine Plant Diversity (17 Hours)

Introduction; major aquatic biomes of the world; marine ecosystems - introduction and types, zonation, environment. Marine organisms; marine plants. Marine algae: macroscopic and microscopic; major groups of marine microscopic algae; algal blooms; Planktons, Nektons, Benthos. Marine Phytoplanktons: Dino-flagellates, Nano-plankton, ultra-plankton, coccoliths. Marine fungi, lichens and marine microbiome. Vegetative and reproductive account of Cyanophyceae, Bacillariophyceae, Chlorophyceae, Rhodophyceae and Phaeophyceae. Collection, preservation and herbarium preparation of marine macroscopic algae. Economic importance of marine algae: food, fodder, medicine, industry, etc.

Module II: Mangroves and their Biodiversity (17 Hours)

Introduction to creek, estuary, lagoon and delta formations. Mangrove ecosystem: Definition; ecology and vegetation of mangroves; distribution of mangroves in India, Mangroves of Kerala; Mangrove diversity of Northern Kerala. Mangrove vegetation: Diversity, ecological significance. Adaptations of true mangroves: anatomical, physiological, morphological, vivipary. Mangrove families in Kerala – taxonomy and diversity, major mangrove species of Kerala; mangrove associates. Regeneration in Mangroves; methods of natural and artificial regeneration in mangroves. Conservation of mangroves; mangrove conservation initiatives in Kerala.

Module III: Marine Ecology (12 Hours)

Detailed account of the physical and chemical parameters of ocean water. Ocean water movements; *El Nino, La Nina*. Microbial ecology of coastal ecosystem; mycorrhizal relations, coastal vegetation. Microbial ecology of coral reefs: occurrence, distribution and types. Calcification, reef algae, natural and anthropogenic stress, restoration and conservation of coral ecosystem. Cultivation of marine algae; *in vitro* cultivation of algae.

Module IV: Pollution and Conservation of Marine Ecosystem (8 Hours)

Marine pollution: Types of pollutants, sources and effects. Toxic metals, oil spill, sewage, fertilizers and pesticides, radioactive pollutants; disposal of waste in oceans; biomagnification. Conservation of marine and mangrove ecosystems; importance of conservation; major conservation initiatives in India.

Practical (36 Hours)

1. Field visit to a nearest coast and submit a report on the floristic diversity.
2. Conduct a field visit to nearby mangrove area and submit a report on the floristic diversity and ecology.
3. Identify the presence of pollutants in sea water.
4. Conduct water quality parameters of sea water.

References

1. Dawes, C. J. 1998. *Marine botany*. John Wiley & Sons.
2. Dawson, E. Y. 1960. A review of the ecology, distribution, and affinities of the benthic flora. *Systematic Zoology*, *9*(3/4), 93-100.
3. Lobban, C.S. and Harrison, P.J. 1985 Seaweed ecology and physiology. Cambridge University Press.
4. Naskar, K. and Mandal, R. 1999. *Ecology and biodiversity of Indian mangroves* (Vol. 1). Daya Books.

MSBOT03 O07 FORENSIC BOTANY

Course Objectives

On completion of the course, the students will understand the basics of forensic science and forensic botany, and also the modern techniques utilized in forensic investigations. They will identify available botanical evidences and apply appropriate techniques for their identification in forensic investigations. Students will also be able to explain the legal and ethical aspects of forensic procedures. The students will be able to apply their understanding of forensic science principles in criminal investigations.

Theory (54 Hours)

Module I (12 Hours)

Introduction to forensic science: Definition, history, development and scope; forensic science in India. Basic principles of forensic science and its significance, organization and functioning of Forensic Science Laboratories, forensic laboratories in Kerala. Legal and ethical considerations in forensic science: adherence to legal procedures; respect for rights and privacy; chain of custody; impartiality and objectivity; confidentiality and data protection.

Module II (20 Hours)

Introduction to forensic botany: Scope and importance of Botany in forensic science. Plant identification; classification of plants; characters used for identification and classification; morphology, anatomy, phytochemistry and palynology; ecology of plants. Various types of woods, components of wood and their forensic significance. Types of fibres; forensic aspects of fibre examination, fluorescent, optical properties, refractive index, birefringence and dye analysis; identification and comparison of man-made and natural fibres. Aquatic microscopic algae; planktons and diatoms and their forensic importance. Diatom types, morphology, methods of isolation from different tissues. Forensic palynology, study and identification of pollen grains, pollen morphology; identification of starch grains, powder and stains of spices. Paper and paper pulp identification, microscopic and biochemical examination of pulp material.

Module III (10 Hours)

Common poisonous plants: Locally available poisonous plants belonging to the families Anacardiaceae, Fabaceae, Apocynaceae (s.l.), Euphorbiaceae, Liliaceae and Loganiaceae.

Plants yielding drugs of abuse: *Opium, Cannabis, Coca,* Tobacco, *Datura.* Common poisonous fungi; fungal toxins.

Module IV (12 Hours)

Collection and preservation of botanical evidences for forensic investigations: Standards and guidelines for forensic botany data collection; samples of botanical origin; collection protocols; preservation of data; outdoor crime scene investigation. Samples analysis and interpretation; quality assurance; documentation and reporting data. Modern tools used in Forensic Botany: molecular techniques; DNA analysis and barcoding; high-resolution imaging techniques. Classic forensic botany case studies: Case histories by using plant anatomy and systematics, palynology, plant ecology, limnology, plant molecular biology and drug enforcement.

Practical (36 Hours)

1. Collection and submission of classic forensic botany cases: Case histories by using plant anatomy and systematics, palynology, plant ecology, limnology, plant molecular biology and drug enforcement.
2. Collection and study of samples containing diatoms, planktons, pollen grains and fibres.

References

1. Alan, G. 2009. Essential Forensic Biology, 2nd Edition, Wiley Blackwell.
2. Bhukya, T. 2023. *Identification of Woods: In Forensic Science*. http://dx.doi.org/10.2139/ssrn.4447076.
3. Bock, J.H. and Norris, D.O. 2015. *Forensic Plant Science.* Academic Press.
4. Coyle, H.M. 2004. Forensic Botany: Principles and applications to criminal casework, 1st Edition, CRC Press Pvt Ltd, Taylor and Francis Group, United Kingdom.
5. Coyle, H.M. 2005. *Forensic botany: principles and applications to criminal casework.* CRC Press, Boca Raton, FL.
6. Coyle, H.M., Lee, C.H., Lin, W.Y., and Palmbach, T.M. 2005. Forensic Botany: Using Plant Evidence to Aid in Forensic Death Investigation. *Croatian Medical Journal*, 46(4): 606-612.

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9. Hawksworth, D.L. and Wiltshire, P.E.J. 2011. Forensic mycology: the use of fungi in criminal investigations. *Forensic Science International*, 206:1-11.
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12. Keshamma, E., Srusti, S.N.R., Prathibha, K.Y. and Tongkachok, K. 2022. *Forensic Botany: An Essential Clue of Criminal Investigation*. Book Saga Publications. Top of Form.

MSBOT03O08 ARTIFICIAL INTELLIGENCE FOR LIFE SCIENCE STUDIES

Course Objectives

The course will enable the students to understand the fundamental concepts of Artificial Intelligence and its applications in life sciences. They will gain practical knowledge for applying AI techniques to various areas of life sciences, including genomics, botany, and ecological conservation. They will also develop critical thinking skills to assess the ethical implications and societal impacts of AI in life sciences research and applications.

Theory (54 Hours)

Module I (12 Hours)

Introduction to Artificial Intelligence: Definition and brief history. Types of AI: Narrow AI vs. General AI, Applications of AI in various fields. Machine learning fundamentals: supervised, unsupervised, and reinforcement learning. Basic algorithms: Linear regression, logistic regression, decision trees, etc. Deep learning basics: Neural networks architecture, Convolutional Neural Networks (CNNs) for image data, Recurrent Neural Networks (RNNs) for sequential data. Ethical Considerations in AI: Bias and fairness in AI algorithms, Privacy concerns, AI and its impact on society.

Module II (15 Hours)

AI for Life Science Studies: Introduction to AI in Life Sciences; overview of biology, genetics, and bioinformatics. Importance of data in life sciences research. Applications of AI in Genomics: Genome sequencing and analysis, predictive modelling for genetic diseases, Personalized medicine and precision healthcare. AI in drug discovery and development: Drug-target interactions prediction, drug repurposing using AI, Clinical trial optimization with machine learning. AI for healthcare management: Predictive analytics in healthcare, medical imaging analysis using AI, Electronic Health Records (EHR) management with AI.

Module III (15 Hours)

AI for Botanical Studies: Introduction to AI in Botany; plant anatomy and physiology, importance of botanical research in agriculture and ecology. AI Applications in Plant Identification: Image-based plant species recognition, plant disease detection using machine learning, remote sensing for vegetation analysis. AI for crop improvement: Genomic selection for crop breeding, precision agriculture and AI-driven farming techniques, Climate

change modelling and its impact on plant ecosystems. AI for ecological conservation: Biodiversity monitoring using AI, habitat modelling and species distribution prediction, AI-enabled conservation planning.

Module IV (12 Hours)

AI for Research and Publication: Literature review automation; introduction to literature review in research, text mining techniques for automated literature search; citation network analysis and literature clustering; tools and platforms for literature review automation. AI-assisted experimental design, data analysis and visualization using AI, AI for manuscript writing and editing; grammar and style correction using AI-based writing assistants, automated summarization and abstraction of research findings. Reference management software and tools.

Practical (36 Hours)

1. Practical identification of flowering plants using image-based AI tools.
2. Design an experiment using AI tool.
3. Case study of AI application in healthcare.
4. Demonstration of basic algorithms used in AI.

References

1. Gupta, S.D., and Ibaraki, Y. (Eds.). 2014. Plant image analysis: fundamentals and applications. CRC Press.
2. Holmes, J., Sacchi, L., and Bellazzi, R. 2004. Artificial intelligence in medicine. *Ann R Coll Surg Engl*, 86: 334-8.
3. Stokes, A. M., Choi, K. L., and Cai, T. 2020. Applications of Machine Learning in Drug Discovery and Development. Nature Reviews Drug Discovery. DOI 10.1038/s41573-019-0058-0.
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SEMESTER IV

CORE COURSES

MSBOT04 C15 CELL AND MOLECULAR BIOLOGY

Course Objectives

To provide students with a comprehensive understanding of the fundamental principles governing life at the cellular and molecular levels and to prepare them for further study or careers in biological research, medicine, biotechnology, and related fields. The specific objectives are to understand molecular mechanisms underlying cellular functions, such as transcription, translation, gene regulation, and genetic variation. Familiarization with laboratory techniques commonly used in cell and molecular biology research is also envisaged.

Theory (72 Hours)

CELL BIOLOGY

Module I (20 Hours)

Unit 1: Cell cycle dynamics and regulation: Overview of the cell cycle phases: significance of each phase in cell growth, DNA replication, and cell division. Spindle formation, microtubule dynamics, motor proteins and chromosome segregation; meiosis and genetic control and consequences of meiosis, gamete formation and genetic diversity. Types and phases of meiosis. Molecular mechanisms of homologous recombination and crossover. Meiotic errors: non-disjunction, aneuploidy, and chromosomal abnormalities. Regulation of cell cycle progression. Role of cyclins and cyclin-dependent kinases (CDKs). CDK activating kinase (CAK) and CDK inhibitory proteins (CKIs). Checkpoints in the cell cycle and their importance in maintaining genomic stability. Role of cohesins and condensins.

Unit 2: Programmed cell death and cancer: Pathways leading to programmed cell death (apoptosis, necrosis, autophagy). Aging at cellular and extracellular levels: Telomere shortening, senescence, and age-related diseases. Carcinogenic agents and phenotypes of transformed cells in cancer development. Cancer progression and metastasis, genetic basis of malignant transformation: oncogenes, tumor suppressor genes, and genomic instability. Interplay between cell cycle regulation and cancer development. Mechanisms of metastasis: invasion, intravasation, circulation, extravasation and colonization.

Module II (16 Hours)

Unit 3: Cell differentiation and cell-cell interactions: Stem cells and cell potency, types of stem cells: embryonic, adult, and induced pluripotent stem cells. Molecular mechanisms regulating stem cell potency and fate determination. Molecular mechanisms of cell differentiation. Transcriptional and translational control of gene expression during differentiation. Role of gene amplification, rearrangement, and transposition in cellular differentiation. Cell-cell interactions and extracellular matrix. Role of extracellular matrix (ECM) in cell adhesion, migration, and signaling. Cell adhesion molecules: cadherins, integrins, selectins, and immunoglobulin superfamily. Junctional and non-junctional adhesive mechanisms: tight junctions, desmosomes, gap junctions and plasmodesmata.

MOLECULAR BIOLOGY

Module III (20 Hours)

Unit 1: Expression of genetic information: Comparative account of transcription in Prokaryotes and Eukaryotes. Role of promoter sequences, sigma factors. Cis-regulatory sequences. Transcription factors, RNA processing and Primary transcripts. Role of spliceosomes. Expression of genetic information: translation; the genetic code: features; translational events: activation of amino acids, initiation, elongation and termination. Role of Initiation Factors, Shine-Dalgarno sequence, Kozak sequence, etc. Differences in eukaryotic and prokaryotic translation events. Post-translational modifications.

Unit 2: Regulation of gene expression: Transcriptional regulation mechanisms, epigenetics and chromatin remodelling, post-transcriptional regulation: RNA processing, stability, and localization, regulatory non-coding RNAs: microRNAs, lncRNAs, and circRNAs. RNA processing control, translational control mechanisms, role of microRNAs. Post-translational control mechanisms. Brief account of Operon concept in bacteria.

Module IV (Self study) (16 Hours)

Unit1: The nucleus and chromatin organization. Organization of eukaryotic chromosome nucleosome model. NPC protein, nuclear import and export. Structure, organization and functions of nucleolus. Structure and organization of chromosomes. Heterochromatin: constitutive; euchromatin, satellite DNA. Karyotype: concepts and its importance. Chromosome banding and its significance. Mitochondrial and chloroplast genome. Chromosome aberrations; numerical chromosome aberrations: aneuploids and euploids. Effects of aneuploidy on phenotype. Structural chromosome aberrations: types and significance in evolution. Special Chromosomes: polytene and lamp-brush chromosomes.

Meiotic errors: non-disjunction, aneuploidy, and chromosomal abnormalities. Association of meiotic defects with human disorders and infertility. Therapeutic potential of stem cells in regenerative medicine.

Unit 2: Mutation, recombination and repair. Mutagens and mutagenesis. Types of mutations: point mutations, insertions, deletions, etc. Spontaneous and induced mutations. Ames test. DNA damage and repair mechanisms. Types of DNA repair: mismatch, base excision repair, nucleotide excision repair, photoreactivation, double strand break repair, translation synthesis, recombinational DNA repair and homologous recombination. Non-homologous end joining. Molecular basis of recombination.

Practical (36 Hours)

1. Meiosis: *Rhoeo/Chlorophytum/Crotalaria/Datura* or any other available plant.
2. Calculation of Mitotic index.
3. Study of polytene chromosomes, lamp brush chromosomes and B chromosomes.
4. Analysis of the given karyotype.
5. Induction of polyploidy using colchicine.
6. Extraction of DNA from plants.
7. Agarose gel electrophoresis of DNA.

References

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2. Berk, A., Kaiser, C.A., Lodish, H., Amon, A., Ploegh, H, Bretscher (Authors), Monty Krieger, A. and Martin, K.C. (Eds). 2016. Molecular Cell Biology. Freeman & Co., USA.
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ELECTIVE COURSES

A student shall select two courses of the courses offered by the Department from the eight courses, one course from the bunch MSBOT04 E01 to MSBOT04 E04 and the second course from the bunch MSBOT04 E05 to MSBOT04 E08.

MSBOT04 E01 APPLIED ANGIOSPERM TAXONOMY

Course Objectives

The objectives of this course are to familiarize with the local flora and to train in field identification of flowering plants, their scientific documentation; to acquaint with the procedure of recording plant data and field data scientifically for future reference; to train on the scientific collection of all major groups of plants for herbarium documentation; to provide adequate training in writing plant description, preparation of identification keys, and on proper utilization of databases for correct application of plant names; to equip on the methods and procedure to be adopted for publishing the discovery of new taxa in scientific journals and to prepare students on the method of drafting research proposal for submission for financialassistance from various funding agencies.

Theory (72 Hours)

Module I (18 Hours)

Plant exploration: Field study and collection of specimens: General collections, special collections; recording of data in the field; collection of special groups of plants: aquatic plants, succulents, banana, bamboos, palms. Preparation and preservation of specimens: herbarium, pickled specimens, wood samples. pollen, seeds; major herbaria of the world; herbarium ethics. Herbarium management: Herbarium building and storage facilities. Pest and insect management, fumigation. Loan and exchange, database management. Handling of herbarium specimens; curation of special groups. Management of type specimens.

Module II (20 Hours)

Preparation of analytical illustrations, tools used in botanical illustrations. Plant illustrations; photographs vs. illustrations; basic drawing materials. camera lucida drawing. Cyber taxonomy; application of information technology in taxonomy; online data bases: IPNI, POWO, WCSP, The Plant List, Tropicos, GBIF, Digitizing herbaria; digital herbaria. Brief account of DNA barcoding in plants; DNA taxonomy; major markers used (ITS, chloroplast

genome, etc.) in DNA taxonomy; reverse taxonomy.

Applications of taxonomy: forensic science, pharmacognosy, horticulture, agriculture, food processing, plant breeding, phytogeography, palynology, biodiversity conservation and Forestry.

Module III (18 Hours)

International Code of Nomenclature for Algae, Fungi and Plants (ICN): How to publish a new combination, names at new rank or replacement name. Best practices for publishing new names. How to designate a type. Basic rules for types, the typification process, best practices for designating a type - case study. Procedure involved in the recognition and publication of a new plant taxon. Preparation of taxonomic research articles for publication: format and major components of the article. Publication ethics.

Module IV (18 Hours)

Preparation of Floras, e-floras, Monographs and Revisions; common format of nomenclatural citations, components of a reliable e-flora. Major sources of general taxonomic references: TaxLit (Taxonomic Literature), Kew Record of taxonomic Literature, Biodiversity Heritage Library, BPH (Botanico Periodicum Huntianum), Index Herbariorum, Authors of Plant Names. IUCN Red List Categorization: Procedures of evaluation and categorization.

Taxonomic Research projects: Plan and presentation of project proposals. Relevance of taxonomy to human society; bioprospecting. Major funding agencies.

Practical (36 Hours)

1. Prepare herbarium specimens of special groups of plants (at least one each from aquatic plants, succulents, banana, bamboos, palms).
2. Work out nomenclature problems, especially involving combination *nova,* change in rank and typification.
3. Prepare and submit complete botanical illustration of a flowering plant in Indian ink.
4. Visit any accredited herbarium and submit a report.

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5. Naqshi, A.R. 2019. *An Introduction to Botanical Nomenclature*. Scientific Publishers, Jodhpur.
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13. Thiers, B.M. 2020. *Herbarium*. Timber Press, Portland, USA.

MSBOT04 E02 WETLAND ECOLOGY

Course Objectives

The main objectives of this course are to understand the concept and components of wetlands and their significance, various threats faced by them and strategies for their conservation. The student will familiarize the major types of wetlands, their role, biodiversity and the modes of conservation.

Theory (72 Hours)

Module I: Wetlands (16 Hours)

Introduction to wetlands: Definition and classification of wetlands (hydrological, vegetative, geographical, functional and global classification). Fresh water and coastal wetlands: an overview; global distribution with special reference to Kerala and its importance. Wetland vegetation: vegetation dynamics and succession. Wetland plant communities and associated fauna.

Module II: Mangrove Ecology (20 Hours)

Mangrove biology and adaptations: Importance of mangroves in coastal ecosystems; types of mangrove vegetation; morphology and anatomy of mangrove plants. Physiological adaptations to saline environments. Reproduction and dispersal mechanisms. Major species of mangroves in India and their status. Ecological and physiological function of mangroves: carbon sequestration and blue carbon storage, productivity; coastal protection and erosion control. Nursery habitat for marine species.

Module III: Conservation Practices (18 Hours)

Mangrove restoration practices: Role of NGOs and Government in conservation; international efforts in conservation; conservation status and legal frameworks. Restoration techniques and case studies. Community-based conservation initiatives; mangrove nurseries and planting techniques. Conservation efforts by Kallen Pokkudan and Dr. Kathiresan. Traditional farming systems in mangrove ecosystem (Kaipad, Pokkali) and their significance. Traditional rice varieties and hybrid varieties developed to promote saline paddy cultivation.

Module IV: Wetland Biodiversity (18 Hours)

Wetland associated algae and fungi; marine and fresh water (mangrove and paddy field) ferns and bryophytes; aquatic angiosperms. Field and laboratory techniques, adaptations, ecology,

physiology, applications; role in biodegradation and biotechnology. Invasive plant species and their impacts on the wetland ecosystem. Reasons for loss of biodiversity in wetlands. Anthropogenic threats to wetlands; deforestation and land conversion. Pollution and habitat degradation. Climate change and sea-level rise.

Practical (36 Hours)

1. Estimation of water quality parameters of selected ecosystems:
    a. pH
    b. Acidity
    c. Alkalinity
    d. Hardness
    e. Macro and micro nutrients
    f. Total solids, dissolved solids and suspended solids.
    g. Turbidity
    h. Electrical conductivity
    i. Dissolved oxygen
2. Estimation of primary productivity of an aquatic ecosystem.
3. Estimation of selected pollutants and microbiological parameters of an aquatic ecosystem.
4. Study of the plant diversity of an aquatic ecosystem.

References

1. Boyer, J.K. and Feller, I.C. Methods for studying mangrove soil Biogeochemistry.
2. Herrera-Silveira, J.E.R. and Rivera-Monroy, V.H. Nutrient cycling in Mangrove forests.
3. Husain, S.N. and Pandey, A.K. Mangrove Ecology, Silviculture and conservation.
4. Jayakumar, M., Balachandran, S. and Varghese, K.P. Wetland Ecosystems in Kerala: Status, Threats, and conservation.
5. Jorgensen, Y., Miyagi, and Moller, A.P. The Ecology of mangrove and related Ecosystems.
6. Mitsch, W.J., and Bernal, B. 2012. Ecosystem ecology of wetlands: Concepts and applications.
7. Mitsch, W.J. and Gosselink, J.G. 2015. Wetlands (5th ed.). John Wiley & Sons.
8. Richardson, C.J., and Vepraskas, M.J. 2017. Wetland Soils: Genesis, Hydrology, Landscapes, and Classification (2nd ed.).

9. Saintilan, N., Wilson, S.C. and Rogers, K.A. Methods for soil and plant Analysis in Mangrove Ecosystems.
10. Trivedy, K.K., Goel and Trisal, C.L. Practical methods in Environmental Science.
11. Vishnudas, C.K. and Sasidharan, N. Wetlands of Kerala: A Vanishing Heritage.

MSBOT04 E03 AGROECOLOGY

Course Objectives

Major objectives of the course are to develop a vision of agriculture as a social and ecological activity for which we have many diverse demands; gaining general understanding of both the natural and social sciences of agriculture, including inquiry in to their basic methods of; to familiarize the conservation initiatives in agriculture; and to learn the role of nutrients for the growth of crops.

Theory (72 Hours)

Module I: Need of Agroecological studies (8 Hours)

Human population growth. Food security and food safety. Need of sustainable agroecosystems for the food safety. Significance and scope of agroecosystem studies for the enhancement of agricultural production.

Module II: Principles and Concepts in Agroecology (20 Hours)

Major principles and concepts in agroecology. Detailed study of the salient features of agroecosystems, examples: paddy ecosystem, forest gardens and plantations. Water and nutrient cycling in agroecosystems. Weed ecology and management; distribution and sampling of agricultural pests; introduction to population dynamics of pests; pesticides and the environment; integrated pest management; plant-parasitic nematodes. Energy flow in agroecosystems. Comparative productivity of various agroecosystems.

Module III: Soil Ecology in Agroecosystems (20 Hours)

A detailed account of the soil types and classification; soil properties and environmental factors. Fertilizer elements in the environment; macro and micronutrients and their availability to crops; alkalinity, acidity and nitrogen in agroecosystems. Decomposition: beneficial soil organisms. Soil health and nutrient management strategies in agroecosystems. Strategies to improve water management in agroecosystems. Soil conservation techniques, contour farming and cover cropping, windbreaks and riparian buffers.

Module IV: Agrobiodiversity and its Conservation (24 Hours)

Agrobiodiversity: A general account on indigenous varieties of major crops: rice, pepper, coconut, jackfruit, tubers, banana and mango. Need of conservation of biodiversity for sustainable agriculture. Landscape ecology and habitat management in relation to

biodiversity. Impact of agriculture on biodiversity. Threats to diversity of local varieties, landscapes; cultivation methods and management of agroecosystems. Beneficial microbes and insects for the agroecosystems. IPR, GI tagging of crop varieties.

Conservation initiatives: Seed banks and genetic resources. Sustainable crop management practices. Traditional knowledge systems and agrodiversity management; Access Benefit sharing (ABS). Agro-ecotourism and conservation, Case studies in integrated agroecology and conservation. Agriculture in Concert with the Environment (ACE) of EPA: mission and salient features.

Practical (36 Hours)

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).

References

1. Amaresan, N., Krishna Kumar, A., Sankaranarayanan, K., Annapurna and Senthil Kumar, M. (Editors). 2020. Beneficial Microbes in Agro-Ecology: Bacteria and Fungi, Academic Press,
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4. Harlan J.R., Gepts P., Famula T.R., Bettinger R.L., Brush S.B., Damania A.B., McGuire P.E., Qualset C.O. 2012. *Biodiversity in Agriculture: Domestication, Evolution, and Sustainability*. Cambridge University Press.
5. Madden, J.P. 2024. The Early Years. *Historical Timeline*. Sustainable Agriculture Research & Education.
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MSBOT04 E04 ETHNOBOTANY AND BIOPROSPECTING

Course Objectives

Major objectives of the course are to understand the relationship of plants with man; understand the diversity of indigenous population and role of plants in their life; to appraise the value of traditional knowledge and the need of its conservation; to apply the knowledge of ethnobotany in quality human life and sustainable development and to develop novel products and services by the utilization of traditional knowledge and natural phenomena.

ETHNOBOTANY

Theory (72 Hours)

Module I (10 Hours)

Ethnobotany: Definition, significance, scope and categories. Man-plant relationship, history, indigenous uses of plants; local and global food systems, cultural and social aspects of food. A brief account of the tribes of India; tribes of Kerala. Role of ethnobotany in art, craft, ecology, conservation and sustainable development.

Module II (26 Hours)

Linkage of ethnobotany with other disciplines: Archaeology, Anthropology, Agriculture, History, Palaeontology. Indigenous agriculture practices; preservation of seeds and planting materials. Biodiversity conservation by indigenous groups; role of ethnic groups in conservation of plant genetic resources; sacred groves; major sacred groves of northern Kerala, rare habitats and plants; minor forest products, medicinal plants; plants and plant products used in rituals, ceremonies and magico-religious beliefs. Sacred plants; traditional ecological knowledge in agriculture and Conservation; indigenous farming systems.

Ethnomedicobotany and ethnopharmacology: folk medicines, plant-derived medicines and their preparation, bioactive compounds; traditional healing practices. Wild food plants, intoxicants, beverages, resins, oils and dyes used by the tribes.

Module III (18 Hours)

Documentation of traditional knowledge: threats to traditional knowledge; Peoples Biodiversity Register. Relevance of ethnobotany in the present context; drug discovery; ethnobotany and biotechnology.

Ethical considerations in ethnobotanical studies: legal aspects; intellectual property rights and

traditional knowledge; Traditional Knowledge Digital Library Unit (TKDL).

Modern approach to ethnobotany: Bioprospecting and commercial use of traditional knowledge; reverse pharmacology; database of ethnomedicinal plants and traditional knowledge (IMPPAT 2.0); Traditional Ecological Knowledge Mapping (TEK).

BIOPROSPECTING

Module IV (18 Hours)

Biodiversity and bioprospecting; economic value of biodiversity; ecosystem products and services. ABS, biopiracy. Definition, concept and practice of bioprospecting; traditional and modern bioprospecting. Types of bioprospecting: Chemical prospecting; Gene prospecting; bionic prospecting. Bioprospecting and conservation. Regulations of bioprospecting. Bioprospecting and sustainable development. Bioprospecting and Biological Diversity Act 2002.

Practical (36 Hours)

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.

References

1. Albuquerque, de U.P., Ramos, M.A., Ferreira, W.S. and Medeiros, P.M. 2017. *Ethnobotany for Beginners*. Springer Science and Business Media, Springer Nature, Switzerland.
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MSBOT04 E05 ADVANCED BIOINFORMATICS

Course Objectives

The major objectives of the course are to develop knowledge in the fundamentals of bioinformatics and its recent developments; to understand the theoretical knowledge on various resources of bioinformatics; acquire knowledge on programme languages in bioinformatics, sequence analysis and phylogeny of various groups of organisms; to develop updated knowledge about recent advances in structure prediction and bioinformatics tools used for structure prediction and to interrelate bioinformatics with other branches of biology; and to apply the data derived from bioinformatics.

Theory (72 Hours)

Module I (22 Hours)

Introduction to Bioinformatics; types of data; concept of databases in Bioinformatics. Common Languages in Bioinformatics: PERL, C++ and Python. Python data types, Python variables, Operators, Lists in Python, Operations, Methods, Parameters, Iterators, Generators, Comprehensions and Expressions. Tuples, Python Dictionaries and Sets.

Module II (25 Hours)

Basics in sequence analysis: Basic concept of sequence similarity, identity and homology; definition of homologous, paralogous, orthologous and xenologous sequences. Various file formats for Bio-molecular Sequences: GenBank, FASTA, GCG, MS, NBRF-PIR, ALN/ClustalW2**.** Scoring matrices: Basic concept of scoring matrix, matrices for nucleic acid and protein sequences, PAM and BLOSOM series, principles based on which these matrices are derived. Differences between distance and similarity matrix. Sequence based database search: Tools and techniques used in sequence analysis. Pair wise and Multiple Sequence Alignments. Tools for local, global and MSA: Muscle, T-Coffee, and Clustal-W. Basic concept of sequence alignment: Algorithms - Needleman and Wunch, Smith waterman. Sequence analysis of nucleic acid and protein sequences and interpretation of the results. Applications of sequence analysis. Phylogenetic analysis by PHYLIP, MEGA. Nature of data used in Taxonomy and Phylogeny, description of phylogenetic trees and types of dendrograms. Analysis, interpretation and significance of dendrograms. Transcriptomics: transcriptome analysis: micro-arrays and NGS-RNA seq.

Module III (15 Hours)

Basic principles and methods used for structure prediction: Wave properties. X-ray crystallography: Basic principle-s, X-rays, crystal systems, Bragg's law, diffraction of crystals, structure factor, atomic scattering factor, crystallization. Components and applications of X-ray crystallography in Bioinformatics: Data collection, structure solution and refinement, structure validation. Spectroscopic methods for structure determination. NMR spectroscopy: shielding constant, chemical shift, application of NMR in protein structure determination. Structural information from UV, Visible, IR spectroscopy, Cryo-electron microscopy.

Module IV (10 Hours)

Methods and tools used in structure prediction and visualization: Methods in structure prediction: Chou-fasman method, GOR method, *Ab initio* method and measuring the accuracy of predictions using Q3, homology modelling, different steps in homology modelling. Structure visualization tools: Rasmol, SPDBV, WEBMOL, Cn3D, VMD, molmol, chime.

Practical (36 Hours)

1. Retrieve nucleotide sequences from NCBI.
2. Retrieve protein sequence from protein database.
3. Similarity search using BLAST.
4. Multiple sequence alignment using Muscle, T-Coffee and CLUSTAL-W.
5. Secondary structure prediction of proteins.
6. PDB structure retrieval and molecular visualization.
7. Restriction mapping
8. Construct Phylogenetic tree by PHYLIP/MEGA.

References

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MSBOT04 E06 NUTRITIONAL BIOCHEMISTRY

Course Objectives

The major objectives of the course are to acquire knowledge on various kinds of nutrients, their sources and functional roles in human body; to understand various metabolic reactions associated with different nutrients in human body; to create an awareness on various kinds of metabolic disorders and deficiency symptoms of nutrients; to understand bioprocessing technology in fermentation process and to apply the knowledge of bioprocessing in industrial production of various kinds of useful products.

Theory (72 Hours)

Module I (10 Hours)

Introduction to nutritional biochemistry. Overview of nutritional biochemistry, essential nutrients and their functions. Kinds of nutrients and their sources: Carbohydrates, proteins, lipids, vitamins and their classifications. Biochemical basis of nutrition, digestion, absorption, and metabolism of nutrients.

Plant based nutrition: Health benefits of a plant based diet, nutritional deficiencies and plant sources of essential nutrients, plant based food industries and products.

Module II (20 Hours)

Macromolecules: Carbohydrates - structure, function and metabolism; glycogen metabolism, metabolism of galactose and fructose; Futile cycle. Metabolic defects related to carbohydrates. Proteins; amino acid structure and metabolism; deficiency disorders.

Lipids: structure, function and metabolism. Synthesis of cholesterol. Micronutrients: vitamins - properties, classification and functions. Vitamins as cofactors and coenzymes. Minerals; essential trace elements. Bioavailability and deficiency disorders.

Module III (30 Hours)

Introduction to bioprocess engineering. Overview of bioprocessing, microbial growth kinetics, fermentation kinetics, fermenter design and operation. Types of fermentation processes. Analysis of batch, fed batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors cell culture and bioproduction. Animal cell culture, recombinant protein production, tissue engineering, process optimization strategies, process monitoring and control, quality Control in

bioprocessing. Bioreactors and membrane bioreactors; isolation, preservation and maintenance of industrial microorganisms; kinetics of microbial growth and death, media and sterilization for industrial fermentation; Fermentation kinetics and monitoring.

Module IV (12 Hours)

Applications of nutritional biochemistry and bioprocess engineering in industry. Recent advances and innovations, integration of nutritional biochemistry and bioprocess engineering. Future trends in biotechnology and nutritional sciences. Industrial applications of bioprocess technology: alcohol, acids, solvents, antibiotics, amino acids, single cell protein, single cell lipids. Use of microbes in mineral beneficiation and oil recovery.

Practical (36 Hours)

1. Analysis of effect of acid and alkali on colour, texture, flavor and palatability of vegetables.
2. Study of effect of metals and heat application on colour, texture, flavor and palatability of vegetables.
3. Enzymatic browning reaction in fruits: Apple, Banana.
4. Enzymatic browning of vegetables: Potato, Brinjal.
5. Isolation and estimation of biomolecules (sugars, starch, protein) from food samples (vegetables, fruits, cereals and tubers).

References

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MSBOT04 E07 REMOTE SENSING, GIS AND ECOSYSTEM MODELLING

Course Objectives

The objectives of this course are to understand the basic principles of Remote Sensing and various techniques used in it. The students will get familiar with the energy sources, various platforms and sensing units used for Remote Sensing. They will also be acquainted with the latest technologies in GIS and GPS and their applications in various fields. The students will acquire skill in ecosystem modelling utilizing latest technologies in IT, remote sensing, GIS and GPS.

Theory (72 Hours)

Module I: Remote Sensing (20 Hours)

History and development, definition, concept and principles in Remote Sensing. Energy resources, radiation principles, EM Radiation and EM Spectrum. Stages of Remote Sensing; data acquisition; process of Remote Sensing data analysis. Types of Remote Sensing: active and passive remote sensing. Platforms used in Remote Sensing: Flight platforms - space, satellites, space station, high-altitude, (balloons; aircraft-fixed wing, copters, drones, fixed wing, VTOL); terrestrial. Satellites and their characteristics: geostationary and sun-synchronous. Earth Resources Satellite: LANDSAT, SPOT, IRS, IKONOS satellite series. Sensors: types and their characteristics. Concept of resolution: spatial, spectral, temporal, radiometric. Basic principles, types, steps and elements of image interpretation. Instruments for visual interpretation. Advantages and limitations of Remote Sensing.

Module II: GIS and Earth's Positioning System (20 Hours)

Introduction to GIS; components of GIS; recent trends and applications of GIS; data structure and formats. Data management using MS-Excel, SQL. Spatial data models: Raster and vector. Database design; editing and topology creation in GIS, linkage between spatial and non-spatial data; data inputting in GIS. Rectification, transformation methods; Root Mean Square (RMS) Error.

Concepts and principles of Web GIS; definition and history of Web GIS; significance of Web GIS. Concepts and principles of GIS model, types of GIS models, modelling process. Application of GIS Modelling. Mobile GIS: Characteristics of mobile GIS; benefits of mobile GIS.

Introduction to Navigation and Positioning; Objectives, types of Earth's, Positioning System and comparative account: GPS, GALILEO, GLONASS and GAGAN.

Module III: Ecosystem Modelling (15 Hours)

History, context and key concepts of ecosystem modelling. Differences between models and modelling activities. Ecosystem Modelling: principles, methods and tools to define, parameterize, evaluate and apply models and the visualization and interpretation of their results. Model classification: deterministic models, stochastic models, steady state models, dynamic models. Different stages involved in model building. Ecosystem stability, cybernetics and ecosystem regulation. Ecoinformatics: a brief account and scope in environmental analysis. General account of major ecosystem models. Applications of ecosystem modelling in research, administration and in other sectors.

Module IV: Applications (5 Hours)

Major applications of Remote Sensing: in conservation biology, human presence monitoring, plant health, fire dynamics, terrain analysis, pollution detection and monitoring, Ocean Colour Applications. Applications of GPS in route navigation, forestry and natural resources, GPS tracking, utility, mapping. Applications of GIS, web GIS, mobile GIS and GIS modelling in biological studies. Applications of Environmental informatics and importance of taxonomy in environmental informatics.

Practical (36 Hours)

1. Map/classify vegetation based on aerial imagery.
2. Prepare local land use map using aerial imagery/GIS tools, and verify with land survey.
3. Visit A laboratory undertaking activities involving remote sensing and GIS, and submit a report.
4. Internship/training in remote sensing/GIS, Agrinformatics, Environmental informatics, Ecosystem modelling.

References

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14. Srivastava, P., Pandey, P.C., Kumar, P., Raghubansi, A.S. and Han D. 2015. Geospatial Technology for Water Resource Development. CRC Press, Taylor and Francis.
15. Steede-Terry, K., 2002. *Integrating GIS and the global positioning system*. ESRI.

MSBOT04 E08 MICROBIOME AND METAGENOMICS

Course Objectives

This course aims to develop an understanding of the concept of microbiome and its implications and different microbiomes and their functions. The course also aims to create awareness on human microbiome and their impact on human health; to understand genomes and metagenomes and their significance; and to apply the knowledge of applications of metagenomics on human life.

Theory (72 Hours)

Module I (10 Hrs.)

Overview of microbiome and metagenomics, importance of microbiome in health and disease. Factors influencing microbial diversity. Plant microbiome. Principles of microbial ecology; types of microbial interactions, microbial niches and habitats; host-microbe interactions. Earth microbiome project.

Module II (20 Hours)

Techniques in microbiome research: DNA sequencing technologies, 16S rRNA gene sequencing, Shotgun metagenomics, Bioinformatics in microbiome analysis. Human Microbiome: Composition and diversity of the human microbiome, microbiome-host interactions, role of the microbiome in health and disease, Gut-brain axis and other microbiome-related phenomena.

Module III (20 Hours)

Environmental microbiomes: Microbiomes in soil, water and air. Extremophiles and their adaptations; impact of environmental microbiomes on ecosystems. Microbiome and disease; microbiome dysbiosis in various diseases, infectious diseases and the microbiome, therapeutic interventions targeting the microbiome.

Module IV (22 Hours)

Metagenomics applications: Functional metagenomics, comparative metagenomics, metatranscriptomics and metaproteomics, single-cell genomics in microbiome research. Basic techniques for metagenomics study: gene sequencing and single-cell analyses and identification of genes. Applications of metagenomics: Human microbiome, bio-prospecting novel genes, industrial bioproducts and bioremediation. Biosafety and IPR issues in

metagenomics. Ethics and challenges in microbiome research: Ethical considerations in microbiome studies, challenges in sample collection and data interpretation, future directions and emerging trends in the field.

Practical (36 Hours)

1. Isolation of DNA from Environmental samples (soil microbes) or microbes (culture dependent or independent).
2. Amplification of 16SrDNA/ITS/ Universal gene and sequence analysis.
3. Comparative analysis of amplicon sequences and phylogenetic analysis.
4. Analysis of metagenomes: A practical introduction to bioinformatic tools for metagenome analysis (eg: DOTUR, MGRAST, DMAP, FMAP, QIIME, MOTHUR).

References

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MODEL QUESTION PAPERS

(SEMESTER III & IV)

MODEL QUESTION PAPER (CORE COURSES)

III/IV SEMESTER M.Sc. BOTANY DEGREE EXAMINATION

(2023 Admission onwards)

MSBOT03 C11 ENVIRONMENTAL SCIENCE

Time: 3 Hours Maximum Marks: 60

PART A (Answer any five questions. Each question carries 3 marks)

1. How Sorenson's index of similarity is useful in studying community structure?
2. Explain Agricultural sustainability.
3. How *La Nina* is different from *El-Nino*?
4. List any three types of pollutions. Suggest methods of preventing each type of pollution.
5. Analyse the concept of environmental economics.
6. Outline the steps involved in cost benefit analysis.

5 x 3 = 15

PART B (Answer any three questions. Each question carries 6 marks)

7. Compare *ex-situ* and *in-situ* conservation methods with examples.
8. Grade the role of International bodies in Environmental education.
9. Substantiate the statement: "Pollution effects man and Environment".
10. Compare the provisions in the wildlife protection Act 1972 and Biological Diversity Act 2002
11. Evaluate the significance of PBR.

3 x 6 = 18

PART C (Answer any three questions. Each question carries 9 marks)

12. Classify water pollutants. Analyse their sources and impacts on environment.
13. Compare the various audit systems you have studied and give the basic procedure of each.
14. Proper waste disposal helps to protect our environment. Justify with your observations.
15. Compare the concepts in autecology and synecology.
16. Elaborate the concepts of sustainable development. How can you lead a sustainable life?

3 x 9 = 27

MODEL QUESTION PAPER (OPEN ELECTIVE COURSES)

III SEMESTER M.Sc. BOTANY DEGREE EXAMINATION

(2023 Admission onwards)

MSBOT03 O04 ORNAMENTAL HORTICULTURE

Time: 3 Hours Maximum Marks: 60

PART A (Answer any five questions. Each question carries 3 marks)

1. Explain the concept of push-pull technology in pest control.
2. List different types of cutting tools. Mention use of each.
3. Name some famous gardens in the world and in India, and assign them to the type each belong.
4. Discuss different stages of plant cultivation from pre-planting to post-planting?
5. Summarize the care instructions for indoor *Anthurium* plants.
6. Identify three common diseases of garden plants and their causative agents.

5 x 3 = 15 Marks

PART B (Answer any three questions. Each question carries 6 marks)

7. Describe the components and features of a landscape plan, including plant and non-plant elements.
8. Compare the types of special gardens: botanical gardens, herbal gardens, and butterfly gardens.
9. Explain the differences between formal, informal, and wild garden styles.
10. Compare and contrast the care requirements of *Casuarina* and *Polyalthia*.
11. Describe how rooting hormones work in the process of plant propagation.

3 x 6 = 18 Marks

PART C (Answer any three questions. Each question carries 9 marks)

12. Analyze the benefits and drawbacks of using organic and inorganic fertilizers.
13. Develop a comprehensive guide to select and arrange flowers and foliage for various types of arrangements.
14. Assess the impact of different lawn maintenance practices on grass health and growth.
15. Critically analyze the use of different flowering plants for ornamental purposes, considering factors like soil requirements, sunlight, and care needs.
16. Develop a comprehensive pest control strategy for a mixed garden, incorporating physical, biological and chemical methods.

3 x 9 = 27 Marks

MODEL QUESTION PAPER (ELECTIVE COURSES)

IV SEMESTER M.Sc. BOTANY DEGREE EXAMINATION

(2023 Admission onwards)

MSBOT04 E02 WETLAND ECOLOGY

Time: 3 Hours Maximum Marks: 60

PART A (Answer any five questions. Each question carries 3 marks)

1. What methodology you would follow while raising a mangrove nursery?
2. Explain wetland vegetation dynamics and succession.
3. Comment on carbon sequestration in mangroves.
4. Name any two invasive plant species in mangroves and their impacts on the ecosystem.
5. Discuss the physiological adaptations of mangroves.
6. Outline the steps in the cultivation in Kaipad rice.

5 x 3 = 15

PART B (Answer any three questions. Each question carries 6 marks)

7. Illustrate in detail, the diversity (types) of wetlands. With examples.
8. Grade the role of NGOs in wetland conservation.
9. 'Pollution severely affects wetland ecosystem'. Comment on the statement.
10. List species of true mangroves in India with their status.
11. Evaluate the significance of community-based conservation practices with examples.

3 x 6 = 18

PART-C (Answer any three questions. Each question carries 9 marks)

12. 'Wetlands are not waste land' Justify the statement.
13. Role of mangroves in mitigating pollution and climate change is very relevant. Discuss with examples.
14. Kaipad rice farming is economical as well as eco-friendly. Give your comments to prove this.
15. Evaluate the role of any two mangrove conservators of India.
16. With examples explain the major threats to mangrove ecosystem. How can you conserve these ecosystems?

3 x 9 = 27