KANNURUNIVERSITY

DEPARTMENT OFZOOLOGY

CURRICULUM AND SYLLABI FOR
M. Sc. APPLIED ZOOLOGY PROGRAMME

Choice Based Credit and Semester System (CCSS)

(w. e. f. 2020 Admission)

REGULATIONS, SCHEME AND SYLLABUS FOR M.Sc. APPLIED ZOOLOGY
(BIODIVERSITY: CONSERVATION AND MANAGEMENT)
Effective from 2020 Admission

1. ELIGIBILITY FORADMISSION:

Candidates who have passed and secured at least 55% marks in B.Sc. Zoology (Main) Degree examination of this University or an equivalent examination of any other University is eligible to apply for the M.Sc. Applied Zoology (Biodiversity: Conservation and Management) programme.

Regulations regarding the reservation of the seats are as per the rules of Government of Kerala/Kannur University. Those who have appeared for the final year examination can also apply; however, they should produce the mark-sheet before the preparation of rank list.

2. ADMISSION PROCEDURE:

Admission to the MSc Applied Zoology programmes of the University department shall be made purely on the basis of Entrance Examination.

3. REGISTRATION

a. The Department has Permanent/ Contract faculty members as Student Advisors. Each student at the time of admission will be assigned to an advisor by the Department Council. He/she will advise the student about the academic Programme and counsel on the choice of courses depending on the student's academic background and objective. The student will then register for the courses she/he plans to take for the semester before the classes begin.

b. The Department of Zoology offering MSc Applied Zoology programme shall have the maximum of 20 students that can be admitted taking into consideration the facilities available. The Department Council will be the authority to fix the optionals that can be offered for a Programme while ensuring that sufficient choice is given to each student in all semesters other than Semester 1.Elective courses for the next semester will be announced within 10 days of the end of the previous semester.

c.The student has to complete the prescribed prerequisites for the course before registration. The student within a maximum of 10 working days after the commencement of the classes can change the Optional Course with the consent of HoDin consultation with the Advisor.

d. The Department shall make available to all students a bulletin listing all the courses offered in every Semester specifying the Credits, list of topics the course intends to cover, the name of the instructor, the timetable and examination schedule. This will be made available in the last week of each semester after it is approved by the Department Council, the Dean and the VC.

4. COURSEDETAILS:

a. Credit and Semester system will be followed for the programme. Credit is the measure to assess the value or relative importance of a course, computed on the basis of the time to be devoted for teaching theory and/or practical. Credit defines the quantum of contents/ syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus credits will be assigned on the basis of the number of lectures/tutorials/ laboratory works and other forms of learning required completing the course contents in a sixteen week schedule per semester.

b. Each student at the time of admission will be assigned to an advisor by the department council. He/she will advice the student about the academic programme and counsel on the choice of

course.

c. Three kinds of Courses are offered - Core, Elective and Open Elective Courses (including MOOC courses). Core and Elective Courses are offered by the Department conducting the Programme. Open Elective Courses are offered either by the Department conducting the Programme or by any other Department of the University or via MOOC.

d. Elective Courses are offered by the Department concerned. Open Elective Courses will be offered by other Departments/Centres/Institutions as options. Open Elective Courses can be opted in any of the Semesters during the entire Programme other than the first semester. The maximum students that can be admitted to an Open Elective Course is limited to forty (40) except for MOOC courses. If the student intake in a department is more than 40, then the maximum number of students that can be admitted to an Open Elective course is equal to the student intake.

e. The minimum duration for completion of a two year PG Programme in any subject is four (4)semesters and the maximum period for completion is eight (8) Semesters from the date of registration.

f. Zero Semester : A Semester in which a student is permitted to opt out due to unforeseen genuine reasons.

g. No regular student shall register for more than 24 credits and less than 16 credits per semester.

h. The total credits required for the successful completion of a four semester Programme will be between 72 to 80.

i. Maximum credits assigned to Core Courses for science subjects are 70 % of the total required credits.

j. The Department Council shall design Core, Elective and Open Elective Courses including the detailed syllabus for each Programme offered by the Department. The Department Council shall have the freedom to introduce new courses and/or to modify/redesign existing Courses and replace any existing Course with a new Course to facilitate better exposure and training for the students, with the approval of the Faculty Council and the Academic Council.

k. There shall be a one hour lecture excluding tutorials/seminars and two to three hours of practical work per week for one credit.

5. EVALUATION:

a. Evaluation of the students shall be done by the Faculty member who teaches the Course on the basis of Continuous Evaluation and an End Semester Examination. The proportion of the distribution of marks among End Semester Examination and Continuous Evaluation shall be 60:40.
b. Continuous Evaluation includes Assignments, Seminars and periodic written examinations.
c. The allocation of marks for each component under Continuous Evaluation shall be in the following proportions :

Theory		Practical	
Components	% of marks	Components	% of marks
Test paper	40% (16 marks)	Tests	75% (30 marks)
Viva, Seminar presentations, Discussion, Debate etc.	40% (16 marks)	Record	25%(10 marks)
Assignment	20% (8 marks)	--	--
Total Internal marks	40	Total internal marks	40

Mode of assessment i.e. administering of Test or Tutorial etc. will be decided by the department.

d. A copy of all records of Continuous Evaluation shall be maintained in electronic format in the Department and shall be made available for verification by the University.

e. Performance of each student in an assessment shall be intimated to him/her within two weeks of the conduct of test/ submission of assignment/ report.

f. For the end semester examinations, the duration of a four credit course shall be 3hours.

g. The minimum attendance required for each Course shall be 60% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination. Condonation of attendance to a maximum of 10 days in a Semester subject to a maximum of two spells within a Programme will be granted by the Vice-Chancellor. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meetings of the University Bodies and participation in extra-curricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for Condonation shall repeat the Course along with the subsequent batch.

6. GRADING:

6.1 An alphabetical Grading System shall be adopted for the assessment of a student's performance in a Course. The grade is based on a 6 point scale. The following table gives the range of marks %, grade points and alphabetical grade.

Range of Marks%	Grade Points	Alphabetical Grade
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
Below 50	0	F

6.2.A minimum of grade point 5 (Grade C) is needed for the successful completion of a Course. A student who has failed in a Course can reappear for the End Semester Examination of the same Course along with the next batch without taking re-admission or choose another Course in the subsequent Semesters of the same programme to acquire the minimum credits needed for the completion of the Programme. There shall not be provision for improvement of CE and ESE. A student can sit the ESE again if she/he has successfully completed the CE requirements in a subsequent semester subject to the maximum durations permitted.

6.3. Performance of a student at the end of each Semester is indicated by the Semester Grade Point Average (SGPA) and is calculated by taking the weighted average of grade points of the Courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$GPA = \frac{\text{Sum of (grade points in a course multiplied by its credit)}}{\text{Sum of Credits of Courses}}$$

6.4 At the end of the Programme, the overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above.

6.5. Empirical formula for calculating the percentage of marks will be

% Marks =**(CGPA x 10)+5.**

6.6. Based on the CGPA overall letter grade of the student and classification shall be in the following way.

CGPA	**Overall Letter Grade**	**Classification**
8.5 and above	A+	First Class with Distinction
7.5 and above but less than 8.5	A	
6.5 and above but less than 7.5	B+	First Class
5.5 and above but less than 6.5	B	
5 and above but less than 5.5	C	Second Class

6.7. Appearance for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are compulsory and no Grade shall be awarded to a candidate if he/she is absent for CE/ESE or both.

6.8. A student who fails to complete the Programme/Semester can repeat the full Programme / Semester once, if the Department Council permits to do so. Absence in an examination will be marked zero.

6.9. No student shall be allowed to take more than eight consecutive Semesters for completing the four Semester Programme from the date of enrolment.

7. GRADE CARD

7.1. The Controller of Examinations shall issue the grade cards of all semesters and the consolidated grade card and certificates on completion of the programme, based on the details submitted by the Head of the Departments. This will be in digital form only.

7.2. The Grade Card shall contain the following

(a) Title of the Courses taken as Core, Elective & Open Elective .

b) The credits associated with and grades awarded for each Course.

c) The number of credits (Core /Elective / Open Elective) separately earned by the student and the SGPA.

d) The total credits (Core / Elective / Open Elective) separately earned by a student till that Semester.

7.3. The consolidated grade statement issued on completion of the Programme shall contain the name of the Programme, the Department/School offering the Programme, the title of the Courses taken, the credits associated with each Course, grades awarded, the total credits (Core /Elective/Open) separately earned by the student, the CGPA and the class in which the student is placed. Rank Certificates will be issued based on CGPA calculated at the end of the last semester of that Programme.

8 DEPARTMENT COUNCIL

8.1 All the Permanent and Contract teachers of the Department shall be the members of the Department Council.

8.2 The Department Council subject to the Regulation shall monitor every academic programme conducted in the Department.

8.3 Department Council shall prescribe the mode of conduct of courses, conduct of examinations and evaluation of the students.

8.4 An elected student representative also may attend the department council meeting where agenda related to academic matters / research activities of students are discussed.

SEMESTER WISE DISTRIBUTION OF PAPERS, MARKS, CONTACT HOURS AND CREDITS

First Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
	Course details/marks	L	T/S	P	End Sem	Internal	Total	
MSZOO01C01	Philosophy of Science and History of Biology	4	1	4	60	40	100	4
MSZOO01C02	Chemistry for Biologists	4	1	4	60	40	100	4
MSZOO01C03	Physics for Biologists and Statistics for Biologists	4	1	4	60	40	100	4
MSZOO01C04	Biosystematics, Taxonomy and Ethology	4	1	4	60	40	100	4
MSZOO01P01	Practical – I (Biochemistry)	6			60	40	100	3
MSZOO01P02	Practical – II (Biophysics & Biostatistics)	6			60	40	100	3
	Total				360	240	600	22

Second Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
	Course details/marks	L	T/S	P	End Sem	Internal	Total	
MSZOO02C05	Cytogenetics, Molecular Biology and Molecular evolution	4	1	4	60	40	100	4
MSZOO02C06	Biotechnology & Bioinformatics	4	1	4	60	40	100	4
MSZOO02C07	Comparative Animal Physiology	4	1	4	60	40	100	4
MSZOO02E01*	Immunology *	4	1	4	60	40	100	4
MSZOO02O01	Remote sensing and GIS for Life Sciences	4	1	4	60	40	100	4
MSZOO02P03	Practical – III (Cytogenetics, Molecular Biology and Biotechnology)	6			60	40	100	3
MSZOO02P04	Practical – IV (Animal Physiology and Parasitology)	6			60	40	100	3
	Total				360	240	600	22

Third Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
	Course details/marks	L	T/S	P	End Sem	Internal	Total	
MSZOO03C08	Developmental Biology	4	1	4	60	40	100	4
MSZOO03C09	Ecology	4	1	4	60	40	100	4
MSZOO03C10	Conservation Biology –I	4	1	4	60	40	100	4
MSZOO03E02	Conservation Biology –II	4	1	4	60	40	100	4
MSZOO03E03*	Wildlife Biology *	4	1	4	60	40	100	4
MSZOO03O02	Statistics for Biologists							
MSZOO03P05	Practical – V (Developmental Biology)	6			60	40	100	3
MSZOO03P06	Practical – VI (Ecology and Parasitology)	6			60	40	100	3
	Total				360	240	600	22

Fourth Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
	Course details/marks	L	T/S	P	End Sem	Internal	Total	
MSZOO04E04*	Research Methodology – Concepts & Methods*	4	1	4	60	40	100	4
MSZOO04E05*	Parasitology*	4	1	4	60	40	100	4
MSZOO04E06*	Fisheries Biology*	4	1	4	60	40	100	4
MSZOO04C11	Project Work	4	1	4	120	80	200	6
	Total				360	240	600	14

*****Elective paper - choose any two (MSZOO04 E 01, MSZOO04E 02,MSZOO04E 03)

PROJECT WORK

The main objective of introducing a project work in the curriculum is that the student who completes this course should get hands on experience in independent research work in the field of biodiversity conservation and management. He/she should equip himself/herself to face challenges in Conservation Biology and should be able to provide trained manpower in the field. A topic in the optional subject – Biodiversity: Conservation and Management shall be assigned to each student.

The research work related to this topic will be carried out by each student under the supervision of a teacher. The report of the findings shall be submitted by each student in the form of a dissertation which shall be submitted for evaluation a day prior to the date of viva voce examination of the fourth semester. A declaration by the student to the effect that the dissertation submitted by him/her has not previously formed the basis for the award of any degree or diploma and a certificate by the supervising teacher to the effect that the dissertation is an authentic record of work carried out by the student under his supervision are to be furnished in thedissertation.

Assessment of different components of project may be taken as below:

Internal evaluation: 80 marks

Internal evaluation should be done by the Internal supervising teacher on the basis of the involvement of student at various stages of the project work including collection of data in a time bound manner, submission of dissertation as per the time schedule and on the sincerity and punctuality in carrying out the dissertation work

External evaluation: 120 marks

External evaluation of the dissertation and the conduct of Viva Voce examination should be done by two examiners of which one should be an expert from an Academic or research institute from a panel of experts submitted to University by the Head of the Department and the other should be a permanent faculty member nominated by the Head of the Department.

Out of the 120 marks 80 marks may be earmarked for the dissertation, 30 marks for the presentation and 10 marks for the interaction

Pass conditions. The students shall declare to pass the project report course if she/he secures a minimum of 40% marks (internal and external put together). In an instance of inability of obtaining a minimum of 40% marks, project work may be redone and the report may be resubmitted along with subsequent exams through parent department. There shall be no improvement chance for the marks obtained in the project report.

Students are required to undertake a compulsory study tour and a report of tour is to be submitted along with the Dissertation.

CURRICULUM AND SYLLABI FOR MSc APPLIED ZOOLOGY

I SEMESTER
MSZOO01C01 - Philosophy of Science and History of Biology
MSZOO01C02 - Chemistry for Biologists
MSZOO01C03 - Physics for Biologists & Statistics for Biologists
MSZOO01C04 - Biosystematics, Taxonomy and Ethology
MSZOO01P01 - Practical I(Biochemistry)
MSZOO01P02 - Practical II (Biophysics & Biostatistics)

II SEMESTER
MSZOO02C05 - Molecular Biology and Molecular Evolution
MSZOO02C06 - Biotechnology and Bioinformatics
MSZOO02C07 - Comparative Animal Physiology
MSZOO02E01* - Immunology
MSZOO02O01 -Open elective
MSZOO02P03 - Practical III (Molecular Biology and Biotechnology)
MSZOO02P04 - Practical IV (Animal Physiology)

III SEMESTER
MSZOO03C08 - Developmental Biology
MSZOO03C09 -Ecology
MSZOO03C10 - Conservation Biology – I
MSZOO03E02 - Conservation Biology – II
MSZOO03E03* -Wild Life Biology
MSZOO03O02– Open elective
MSZOO03P05 - Practical V (Developmental Biology)
MSZOO03P06 - Practical VI (Ecology and Conservation Biology)

IV SEMESTER
MSZOO04E04* - Research Methodology – concepts and methods
MSZOO04E05* - Parasitology
MSZOO04E06* - Fisheries Biology
MSZOO04C11 - Project Work
*****elective paper

MSZOO01C01 - PHILOSOPHY OF SCIENCE AND HISTORY OF BIOLOGY 90hrs

Course outcome: After the completion of this course, the students will be able to:

Understand what science is and in what ways science differs from non science and pseudoscience subjects

Get a clear picture about what philosophy science is.

Understand the different methods of reasoning in Science.

Get an idea about the modes of scientific explanations.

Understand the role of paradigm shifts in various branches of scientific research; also get an idea about the scientific revolutions in various branches of science

Understand the value, its acceptance and the criticism to Science.

Understand the historical milestones in the evolution of scientific thoughts and research.

Distinguish between different centuries with respect to growth of science and scientific thoughts.

Understand the ups and downs in the history of science, pace of scientific research during 17^{th} to 20^{th} Centuries and contributions made by scientists in the past centuries.

A. Philosophy of science 50 hrs

MODULE I :

1. What is Science? **5 hrs**
- 1.1. Origins of modern science.
- 1.2. Philosophy of Science- definition, scope.
- 1.3. Science andpseudo-science.

2. Scientific Reasoning **9 hrs**
- 2.1. Deduction andinduction
- 2.2. Hume's problem
- 2.3. Probability and induction

3. Explanation in science **12 hrs**
- 3.1. Hempel's covering law model of explanation
- 3.2. The problem of symmetry
- 3.3. Explanation and causality
- 3.4. Can science explain everything?
- 3.5. Explanation and reduction

MODULE II :

4. Scientific Change and Scientific Revolutions **11 hrs**
- 4.1. Logical positivist philosophy of science
- 4.2. The structure of scientific revolutions

Incommensurability and theory ladenness of data
Kuhn and the rationality of science

5. Philosophical problems in Biology **4 hrs**
The problem of biological classification

6. Science and its Critics **9 hrs**
Scientism.
Science and religion
Is Science value free?

B. History of biology 40 hrs

MODULE III:

1. An account on history of science **3 hrs**

Ancient Greek philosophers.

2. History of biology:
History of Biology during Seventeenth century: Anatomists, Microscopists 5 hrs

History of Biology during Eighteenth century: Great chain of being; Carl Linnaeus; Lamarck; Precursors to modern evolutionary theory. 8 hrs

MODULE IV:

History of Biology during Nineteenth century: Birth of associations and societies to promote science; Charles Darwin; Pre-Darwinian evolution; Origin of species; The emergence of biological disciplines; Experimental physiology; Cell theory, cell pathology and germ theory**.** **12 hrs**

History of Biology during twentieth century: 12 hrs

- First half of 20thcentury: Growth of microbiology and Biochemistry; Genetics and heredity
- Second half of 20thcentury: The architects of life - proteins, DNA and RNA; The origins and borderlines of life; Growth of genetic engineering; Growth of Biotechnology; Growth of Genomics; Growth of Recombinant DNA.

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Philosophy of science

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MSZOO01C02 - CHEMISTRY FOR BIOLOGISTS 90 hrs

Course outcome: After the completion of this course, the students will be able to:

- Understand the chemistry behind life forms, also connect biochemistry to their own lives on a variety of levels.
- Understand the fundamental biochemical principles thereby get to know how biochemistry works in the body and under different conditions.
- This course features the laws of thermodynamics, concept of enthalpy, entropy and free energy changes and their application to biological systems and reactions.
- Through this course the students learn about the classification, structure and function of biomolecules such as carbohydrates, proteins, lipids etc.
- The students will able to acquire the basic concepts of bioenergetics and oxidative metabolism. Thus become aware with the metabolic pathways of biomolecules, their regulation, and the importance of high energy compounds.
- The students will become aware of the fundamental knowledge on Enzymes and biocatalysis. They may acquire basic principles to analyze the enzyme kinetics and learn to estimate the activity of enzymes. Studying the enzyme inhibition mechanism introduces the area of treatment strategies for various diseases such as cancer and AIDS.
- Students in the Biochemistry will learn the chemical nature and functions of vitamins.
- The students will develop skills to determine the structure and nature of amino acids.
- This course provides the structure, biosynthesis and degradation of nucleic acids. Students will learn about the structure of DNA and RNA.
- The practical biochemistry course acquire through getting knowledge in biochemical techniques and applying biochemical calculations.
- Students will learn the qualitative and quantitative analysis of constituents of biological fluids such as urine, blood and their estimation using standard methods.
- In this course students will undertake experiments and thus understanding the role of enzymes in clinical diagnosis and industrial applications as well.
- At the end of this course students are able to appreciate the importance of biochemistry in living systems.
- This course facilitates in employability in diagnostic sector and R &D institutes.

MODULE I: **21 hrs**

1. Introduction: **6hrs**

1.1. Biochemistry and organization of cells
1.2. Molecular logic of life
1.3. Chemical unity and biological diversity
1.4. Biopolymers
1.5. The physical roots of the biochemical world
1.6. Laws of thermodynamics in biological system: entropy, enthalpy and concept of free energy

2. Carbohydrates: **6hrs**

2.1. Structure of monosaccharides, disaccharides, oligosaccharides and polysaccharides (chitin, bacterial cell wall and glycogen)
2.2. Physical and chemical properties of monosaccharides

3. Lipids: **9hrs**
3.1. Classification of lipids, classification of fatty acids
3.2. Physical and chemical properties of lipids
3.3. Structural lipids in membranes; Phospholipids, sphingolipids and cholesterol.
3.4. Prostaglandins

MODULE II: **12 hrs**

4. Amino acids and proteins: **12hrs**
4.1. Structure of different amino acids in proteins. Classification of amino acids. Peptide bonds; Zwitter ions.
4.2. Classification of proteins; glycoproteins and proteoglycans
4.3. Structure of proteins; Ramachandran plot
4.4. Nitrogen excretion and urea cycle

MODULE III: **30 hrs**

5. Bioenergetics & oxidative metabolism: **30hrs**

5.1. Introduction to metabolism
5.2.Carbohydrate metabolism- Glycolysis; fate of pyruvate; gluconeogenesis; HMP pathway; glycogenolysis; glycogenesis, Regulation of glycogen metabolism. Citric acid cycle; electron transport chain; oxidative phosphorylation; redox potential; chemi-osmotic hypothesis; uncouplers; inhibitors of electron transport chain.High-energy compounds; role of ATP in the biological system
5.3. Lipid metabolism- Oxidation of fatty acids (saturated, unsaturated and odd carbon). Ketone bodies; Biosynthesis of fatty acids; biosynthesis of cholesterol; Regulation of cholesterol biosynthesis.
5.4. Amino acid metabolism- transamination, decarboxylation and deamination reactions in the biological system; inborn errors in metabolism.

MODULE IV **27 hrs**

6. **Enzymes:** **13hrs**

6.1. Introduction- Classification and nomenclature. Specificity, various factors influencing velocity of enzyme catalyzed reactions
6.2. Michaelis-Menten equation & Kinetics, Line weaver-Burk plot
6.3. Enzyme inhibition-reversible and irreversible (competitive and non-competitive) with examples. Enzyme inhibition in the treatment of AIDS
6.4 Regulatory enzymes-Allosteric enzymes
6.5. Zymogens, isozymes

7. **Nucleic acids:** **8hrs**
7.1 Chemistry, biosynthesis and degradation of nucleic acids
7.2 Structure of DNA and RNA.

8. **Vitamins:** **6hrs**

8.1 Chemical nature and functions of vitamins

8.2 Role of B-complex vitamins as coenzymes.

Chemistry for biologists (References)

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MSZOO01C03 - PHYSICS FOR BIOLOGISTS & STATISTICS FOR BIOLOGISTS

90 hrs

Course outcome: After the completion of this course, the students will be able to:

- Understand the methods of analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy
- Know the processes of determination of the structure of biomolecules using spectroscopic methods.
- Gain knowledge in the field of radio isotopy, its related techniques and instruments.

- Learn about biophysical and electrophysiological methods used mainly for medical applications
- Gain insights into biostatistics, data collection and representation
- Apply and use descriptive, inferential and correlational statistics.
- Learn about probability theory, and identify and recognize theoretical probability distributions.

MODULE-1

1. Biophysical methods:
1.1 Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy.
1.2 Structure determination using X-ray diffraction and NMR, analysis using light scattering;
1.3 Different types of mass spectrometry and surface plasma resonance methods.
1.4 Laser and its application in Biology

2. Radiation biology:
2.1 Properties of different types of radioisotopes normally used in biology, their detection and measurement.
2.1.1 Autoradiography,
2.1.2 G.M. counter
2.1.3 Incorporation of radioisotopes in biological tissues and cells
2.1.4 Applications of tracer techniques.
2.1.5 Radiation protection and therapy; safety guidelines.

3. Bioacoustics:
3.1 Physical basis of hearing
3.1.1 Physical aspects of sound transmission in the ear;
3.1.2 Echocardiography
3.1.3 Ultrasonography.

4. Biophysics of vision:
4.1 Eye as an optical instrument;
4.1.1 Formation of image.

MODULE-2

1. Electrophysiological methods for biophysics:
1.1 Single neuron recoding
1.2 Patch clamp recording
1.3 ECG
1.4 EEG
1.5 PET
1.6 MRI
1.7 CAT

2. Biophysical methods and their applications:
2.1 Microscopy
2.1.1 Bright field
2.1.2 Phase contrast
2.1.3 Fluorescence
2.1.4 SEM
2.1.5 TEM

2.1.6 STEM
2.2 Colorimetry;
2.3 Spectrophotometry
2.4 Flow cytometry
2.5 Gel-filtration
2.6 TLC
2.7 HPLC
6.8 Gel electrophoresis
6.9 Centrifugation
6.9.1 Differential
6.9.2 Density gradient
6.9.3 Ultracentrifugation.

MODULE-3

1. **Introduction to biostatistics**
1.1. Data
1.2. Collection of Data
1.3. Classification of data
1.4. Tabulation of data

2. **Diagrammatic and graphical presentation of data:**
2.1 Bar diagram
2.2 Pie diagram
2.3 Histogram
2.4 Frequency polygon
2.5 Frequency curve

3. **Measures of central tendency:**
3.1 Mean
3.2 Median
3.3 Mode.

4. **Measures of dispersion:**
4.1 Range
4.2 Mean deviation
4.3 Standard deviation
4.4 Quartile deviation

MODULE-4

1. **Probability:**
1.1.Basic concepts
1.2.Laws of probability
1.3.Probability distributions
1.3.1. Binomial distribution
1.3.2. Poisson distribution
1.3.3. Normal distribution

2. **Statistical inference**:
2.1**.** Testing of hypothesis
2.1.1. Null and alternate hypotheses
2.2. Testing of significance

2.2.1. Z-test
2.2.2. *t*-test
2.2.3. X^2 test

3. **Analysis of variance (ANOVA):**
3.1. One way analysis
3.2. Two way analysis

4. Correlation analysis
4.1. Kinds of correlation
4.2. Pearson coefficient of correlation
4.3. Scatter plots

5. Regression analysis
5.1. Regression equations
5.2. Regression lines

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Module-3 and 4

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MSZOO01C04 – BIOSYSTEMATICS, TAXONOMY AND ETHOLOGY (90 hrs)

Course outcomes

After successful completion of this course, students will be able to:

- Develop a knowledge base in the field of Animal Behavior especially of basic terms, key concepts, principles and comprehensive themes in animal behavior
- Develop skills in observing behavior of various groups of animals
- Understand and identify behaviors in a variety of taxa
- Understand fascinating range and complexity of behaviors in animals
- Recognize the relevance of animal behavior, both as a biologist and a human being
- Become familiar with the approaches used in the laboratory and field settings to obtain knowledge about animal behavior
- Understand the importance of fixed and plastic behaviors
- Competently discuss the basic ecological and evolutionary processes that shape various animal behaviors
- Learn to reason scientifically and learn to interpret and design studies in animal behavior and cognition.
- Apply knowledge of behavioral theory to new situations
- Exhibit quantitative research skills
- Demonstrate ability to communicate scientific information in both oral and written formats
- Further develop, the ability to apply critical thinking and logic to the solving of biological problems relating to animal behavior
- Understand basic concept of Taxonomy and its relevance.
- Understand the relevance of Biosystematics and its importance in resolving classical and applied research problems.
- Knowledge of the principles of animal nomenclature and terminology

- Acquire the knowledge of various taxa and understand the importance and applications of various species concept in Systematics
- Understand the merit and demerits of various schools of biological classification.
- Become familiar the basic principles of ICZN and their interpretations in resolving various taxonomic problems.

MODULE I

A. Biosystematics and taxonomy (45 hrs)

1. Definition and basic concepts: Systematics and taxonomy; History of Systematics; Levels of taxonomy-alpha, beta and gamma taxonomy; Importance and goals of Systematics. **(6 hrs)**

2. Classification: Purpose and functions of classification; Types of classification – Artificial, Natural, Downward, Hierarchial, Phylogenetic, Evolutionary. **(6 hrs)**

3. Species Concepts – Typological, Nominalistic, Biological, Evolutionary; Intraspecific categories-Variety, Race, Cline, Subspecies. **(3 hrs)**

4.Taxonomic Procedure: Collecting, Labeling, Curating, Cataloguing, Identification, Description, Redescription, Taxonomic key-Types of key. **(7 hrs)**

MODULE II

5.Taxonomic Characters: Definition; Diagnostic value of taxonomic characters; Kinds of characters – Morphological, Anatomical, Embryological, Cytological, Ethological, Ecological, Biochemical, Geographical, Molecular. **(7hrs)**

6. Zoological Nomenclature: History of Zoological Nomenclature; International Code of Zoological Nomenclature – Operative principles and important Codes. **(6 hrs)**

7. Current trends in Systematics: Biochemical systematics, Cytotaxonomy, Numerical taxonomy, Molecular systematics, Cladistics. **(6 hrs)**

8. Taxonomic Publications: Form and Style of Taxonomic paper – Title, Authors' name, Abstract, Introduction, Acknowledgements, Methods used and materials studied, Body of the text, Summary. Kinds of taxonomic publications – Description of new taxa, Synopses and Reviews, Catalogues and Checklists, Revisions, Monographs, Faunal Works, Atlases, Handbooks and Manuals. **(4 hrs)**

MODULE III **(22 hrs)**

B. Ethology

1. Introduction **(3 hrs)**
Definition and concepts; History; Ethology and its relation to other schools studying behaviour-Behaviourism; Proximate and ultimate causes of behaviour.

2. Instinctive and Learning behaviours **(5 hrs)**

2.1 Instinctive behavior: Fixed action pattern, Sign stimuli, Types of sign stimuli, Supernormal stimuli.

2.2 Learning : Categories of learning- habituation, classical conditioning, operant conditioning, latent learning, insight learning, imprinting, social learning.

3 Complex Behaviour **(4 hrs)**

3.1 Orientation and Navigation in birds
3.2 Ritualization
3.3 Raw materials for ritualization (Intention movements and Displacement activities)

3 Physiology of behaviour **(5 hrs)**

3.1 Neural basis of behaviour
3.1.1 Brain and behaviour
3.2 Hormones and behaviour
3.2.1 Hormonal impact on various behavioural patterns

4 Genetics of behavior **(5 hrs)**

4.1 Hybridization
4.2 Single or multiple gene effect
4.3 Gene mutations which influence behavior
4.4 Relationship between genes and environment in the control of behavior

MODULE IV **(23 hrs)**

5 Biological Communication **(6 hrs)**

5.1 Components of communication system
5.2 Functions; Costs and benefits of signaling
5.3 Channels for communication (vision, audition, chemical senses, touch and electrical fields)
5.4 Complex communication systems (Honey bee dance)

6 Sociobiology **(4 hrs)**

6.1 Types of social groups (Pair, Family, Harem, Matriarchy, Oligarchy, Arena and Hierarchy)
6.2 Social Dominance
6.2.1 Determinants of dominance
6.2.2 Cost and benefits of dominance
6.2.3 Cost and benefits of subordination

7. Reproductive Behaviour **(9 hrs)**

7.1 Evolution of sex and reproductive strategies
7.2 Mating systems (Monogamy, Polygamy, Promiscuity)
7.3. Sperm competition
7.4. Sexual selection
7.5. Parental behavior
7.6.1Types of parental care

7.6.2 General features of parental behavior
7.6.3 Factors affecting parental care
7.6.4 Parent –offspring conflict

8. **Evolution of Behaviour** **(4 hrs)**
8.1 Adaptiveness of behavior
8.2 Cultural transmission of behavior
8.3 Kin selection and inclusive fitness; Altruism and reciprocal altruism.

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MSZOO01P01 - PRACTICAL - I (BIOCHEMISTRY)

1. Quantitative estimation of carbohydrates:
   a. Estimation of blood glucose by colorimetric methods (Nelson-Somoyi or Arsenomolybdate or by Folin-Wu method).
   b. Estimation of total carbohydrate by phenol-sulphuric acid method.
2. Quantitative estimation of proteins:
   a. Estimation of serum proteins by colorimetric method (Biuret method).
   b. Estimation of total proteins from liver by Lowry's method.
   c. Isolation of casein from milk.
3. Quantitative estimation of lipids
   a. Estimation of serum cholesterol by Ferric chloride or Carr-Drektermethod.
   b. Saponification value offat.
   c. Estimation of total lipids in the serum (using phosphovanillin method).
4. Enzyme assays

a. Determination of salivary amylase activity-effect of substrate concentration.
b. Determination of salivary amylase activity - effect of pH.

5. Buffers and pH:
   a. Comparison of the capacities of two buffers of the same pH.

MSZOO01P02– PRACTICAL - II (BIOPHYSICS & BIOSTATISTICS)

Biophysics

1. Absorption spectrum of potassium permanganate.
2. Determination of absorption coefficient and concentration of unknown solutions by calibration as well as by absorption coefficient.
3. Separation of mixtures of sugars and amino acids by paper/thin layer chromatography.
4. Micrometry
5. Phase contrast microscope, camera Lucida, Photomicrography equipment.
6. Determination of coefficient of viscosity.
7. Determination of pH of various biological fluids using pH meter.

Biostatistics

1. Preparation of frequency distribution for the data of a group of people according to height.
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams.
3. Graphic presentation of a population distribution according to age in the form of histogram, frequency polygon and frequency curve.
4. Computation of measures of central tendency and dispersion in anthropometric data of schoolchildren.
5. Simulation of binomial and poison distributions.
6. Estimation of population of birds in the University campus.
7. Design an experiment for the comparison of efficacy of diets of different types animals by the method of ANOVA.
8. Regression analysis and correlation analysis of a data of heights and weights of a group of students.
9. Estimation of organisms in water by Dilution Method.

II SEMESTER

MSZOO02C05 – CYTOGENETICS, MOLECULAR BIOLOGY AND MOLECULAR EVOLUTION 90 hrs

Course outcome:

- Cell and molecular biology is the basic science that has its goal in explaining the life processes at the sub cellular and molecular level.
- The paper provides the structural and functional role of cell organelles and cell membrane at the molecular level. Provide basic understanding of the role of membranes and its transport mechanisms.
- This course summarizes the processes of energy transaction in mitochondria and chloroplast.
- This course provides the basic elements of cell signaling systems and cell-cell communication.
- This course is designed to impart the students to appreciate the phases of cell cycle and cell cycle mechanisms involved in cancer.
- Upon completion of the Cytogenetics part of this course students will able to understand human chromosomes and associated diseases.

- Through learning of this course students will understand the idea about microbial genetics and transposable genetic elements. This paper introduces the life cycle of bacteriophages as well.
- The students of this course learn about the molecular mechanism of Apoptosis.
- This course teaches the evolution and organization of prokaryotic and eukaryotic genomes.
- The course enables the students to acquire knowledge about genes at molecular level. They will learn about DNA, RNA and their replication, mutations, DNA repair mechanism, transcription, protein synthesis, and gene regulation.
- By learning advanced techniques in RNA editing and anti-sense RNA strategies through this course, students get a platform for understanding the advanced techniques and their applications in current research programs.
- The practical course provides hands-on laboratory research experience in Cytogenetics and molecular biology techniques. Students acquire training with Chromosome preparations, cell cycle analysis and karyotyping.
- One major course outcome is to equip the students to understand modern molecular biology techniques for disease diagnoses and therapy.

MODULE I

A. Cytogenetics:

1. **Signal transduction** **(8h)**
   1.1 The basic elements of cell signaling systems.
   1.2 G protein coupled receptors and their second messengers
   1.3 Protein- Tyrosine phosphorylation as a mechanism for signal transduction.
   1.4 Cytokine receptors and JAK/STAT pathway
   1.5 The Ras/MAP Kinase pathway
   1.6 Phosphoinositide signaling pathway
   1.7 The role of calcium as an intracellular messenger

2. The Eukaryotic Cell Cycle: **(7 h)**
   2.1 Overview of cell cycle and its control
   2.2 Regulation of CDK activity
   2.3 Commitment to cell cycle and DNA replication
   2.4 Entry into mitosis
   2.5 Completion of mitosis: Chromosome segregation and exit from mitosis
   2.6 Surveillance mechanisms in cell cycle regulation
   2.7 Meiosis
   2.8 Molecular basis of Neoplasia.

3. **Microbial genetics:** **(3h)**
   3.1 Bacterial transformation, transduction, conjugation and bacterial chromosome.
   3.2 Bacteriophages: structure and morphology of T4and lambda phages.

4. **Transposable genetic elements:** **(3h)**

4.1. Genetic instability and the discovery of transposable elements
4.2. Transposons in bacteria
4.1.1 IS elements, the Tn family
4.1.2 Mu phage as a transposable element
4.2 Transposons in eukaryotes
4.2.1 Controlling elements in maize
4.2.2 P elements in *Drosophila;*
4.3 Retroposon type transposition
4.3.1 Yeast Ty elements
4.3.2 Alu family
4.4 Retroviruses and Retrotransposons

5. Apoptosis: (2h)

5.1 Intrinsic pathway of apoptosis
5.2 Extrinsic pathway of apoptosis

MODULE II

B. Molecular biology:

1. Genes and genomes: (3h)

1.1 Genomes of prokaryotes and eukaryotes
1.2 Organelle genomes
1.3 Evolution of genomes.

2. Characteristic features of eukaryotic genome: (3h)

2.1 Chromosomal content and C-value paradox
2.2 Unique, moderately repetitive and highly repetitive DNA sequences
2.3 Reassociation kinetics of the above types of DNA
2.4 Cot value and complexity of the genome

3. Chemistry and Structure of nucleic acids: (4h)

3.1 Topology of nucleic acids
3.2 Supercoiling and topoisomerases
3.3 Different forms of DNA (A, B, C & Z).

4. Replication of DNA: (8h)

4.1 Models of DNA replication: Semiconservative mode (Experiments of Messelson and Stahl and that of Cairns), rolling circle mode and D-loop mode of replication. Role of antisense RNA in replication initiation in plasmids.
4.2 Okazaki fragments and semi-discontinuous synthesis.
4.3 Enzymes and accessory proteins involved in DNA replication.
4.4 Primosome, replisome, Telomeric DNA and regulation of telomere length; reverse transcription.

5. DNA Repair: (5h)

5.1 Excision repair, mismatch repair light dependant repair and SOS response

MODULE III

6. Transcription in prokaryotes and eukaryotes. (9h)

6.1 Initiation of transcription, elongation, termination and anti-termination
6.2 Promoter, enhancer and silencer sites
6.3 Transcription factors.
6.4 Post transcriptional modification of RNA
6.4.1 Capping and Tailing of mRNA
6.4.2 Removal of intron sequences by RNA splicing in mRNA, *t* RNA and rRNA, Splicing and Ribozyme.
6.4.3 RNA editing- guide RNA.

7. The genetic code: (3h)

7.1 Characteristic features of the genetic code (triplet, comma less, non-overlapping a universal nature of the code).
7.2 Deciphering the code
7.3 Degeneracy of the code: Wobble hypothesis
7.4 Reading frame and frame shift.

8. Details of translation: (7h)

8.1 Initiation, elongation and termination of protein synthesis
8.2 Structure of *t* RNA
8.3 Various steps and factors involved in translation.

9. Regulation of gene expression in bacteria: (4h)

9.1 The operon model. : *Lac* operon, *lac* repressor, negative and positive control
9.2 Basic features of tryptophan operon
9.3 Operator-repressor regulation and attenuation regulation

10. Regulation of gene expression in phages: (3h)

10.1 Circuit of lytic cycle and lysogeny
10.2 Lytic cascade in l phage
10.3 Transduction - generalized and specialized.

11. Regulation of gene expression in eukaryotes: (3h)

11.1 Regulation at transcriptional level
11.1.1 Activation of transcription
11.1.2 Repression of transcription
11.2 Regulation at translational level
11.2.1 Regulation by alternate pathways of transcript splicing
11.2.2 Anti - sense RNA strategies for regulating gene expression; molecular mechanisms of anti-sense molecules.

MODULE IV

C. Molecular evolution 15 hrs

1. Molecules and origin of life:

1.1**.** Origin of basic molecules – origin of organized structures(coacervates, microspheres): RNA world – evolution of protein synthesis - evolution of genetic code; prokaryotes and eukaryotes-evolution of eukaryotic organelle; genetic constancy and variability – chromosomal variation, gene mutation, gene duplication; evolutionary history of hemoglobin, cytochrome C, pseudogenes, genetic polymorphism, eukaryotic clock; genetic drift and gene flow.

6 hrs

2. **Microevolution,** macroevolution and punctuated equilibrium, anagenesis and cladogenesis. 5 hrs

3. **The evolution of genome:** DNA alterations- genome size- gene diversification introns-repeat sequences. 4 hrs

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MSZOO02C06 - BIOTECHNOLOGY & BIOINFORMATICS (90 hrs)

Course outcomes: On completion of the course, students will be able to:

- Understand the basic terms, principles and practices in Biotechnology
- Learn to apply biotechnological principles, methods and models to solve biotechnological tasks.
- Become familiar with the tools and techniques in genetic engineering
- Acquire knowledge on manipulation of genes, transfer techniques, expression systems and methods of selection
- Acquire basic concepts of establishing animal cell cultures
- Understand the applications of animal cell culture technologies
- Understand the applications of biotechnology in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal and forensic sciences.
- Understand the importance and use the biological databases

- Become familiar with algorithms and different methods of sequence alignments as well as execute alignments to address research problems
- Become familiar with a wide variety of bioinformatics tools and software
- Possess the technical background knowledge needed to support biotechnology research activities.
- Develop research aptitude and technical skills to seek a job in the field of biotechnology.

MODULE I

A. Biotechnology

1. Biotechnology: An Overview **(3hrs)**

1.1 Scope and importance of biotechnology
1.2 Biotechnology in India.

2. Chimaeric DNA, Molecular Probes and Gene Libraries **(9hrs)**

2.1 Restriction enzymes for cloning
2.1.1 Techniques of restriction mapping
2.2 Construction of chimaeric DNA
2.3 Molecular probes (production, labeling and uses)
2.4 Southern, northern and western blotting
2.5 Dot and slot blots
2.6 Construction and screening of genomic and cDNA libraries

3. Cloning and Expression Vectors: **(5hrs)**

3.1 Cloning vectors for recombinant DNA (plasmids, phages, cosmids, transposons, YAC, MAC, etc.)
3.2 Expression vectors for high level of expression of cloned genes (use of promoters and expression cassettes including baculovirus)
3.3 Binary and shuttle vectors.

MODULE II

4. Polymerase Chain Reaction (PCR) and Gene Amplification: **(9 hrs)**

4.1 Gene amplification
4.1.1 Basic PCR and its modifications (inverse PCR, anchored PCR, PCR for mutagenesis, asymmetric PCR)
4.1.2 Application of PCR in biotechnology and genetic engineering
4.1.3 DNA polymorphism- RAPDs, VNTRs, SSRs
4.1 Gene tagging
4.2 DNA fingerprinting.
4.3 DNA microarray.
4.4 Molecular markers (RFLPs, RAPDs, mini satellites, microsatellites)

5. Sequencing and Synthesis of Genes: **(5hrs)**

5.1 DNA sequencing.
5.2 Synthesis of genes

5.2.1 Gene synthesis machines.

6. Animal Cell and Tissue Culture: (5 hrs)

6.1 Laboratory facilities
6.2 Scope of animal cell and tissue culture
6.3 Advantages and disadvantages of tissue culture
6.4 Culture media for cells and tissues
6.5 Culture procedures
6.5.1 Primary Culture,
6.5.2 Cell Lines and Cloning:
6.5.2.1 Disaggregation (enzymatic and mechanical) of tissue.
6.5.2.2 Artificial skin and artificial cartilage

7. Hybridoma and Monoclonal Antibodies: (5 hrs)

7.1 Hybridoma technology and the production of monoclonal antibodies
7.2 Antibody engineering using genetic manipulations (Fv, Fab, Fc)
7.3 Uses of monoclonal antibodies (diagnosis, imaging, therapy, vaccines, enzymes, etc.).

MODULE III

8. Biotechnology in Medicine: (8 hrs)

8.1 Animal and human health care (vaccines, diagnosis and cure of diseases including gene therapy)
8.2 Genetic counseling (antenatal diagnosis, fetus sexing)
8.3 Forensic medicine (identification of murderers and rapists, etc.).
8.4 Transgenic animals
8.4.1 Transgenic mice: Methodology (DNA microinjection method and Retroviral vector method)
8.4.2 Transgenic mice applications (Transgenic disease model, transgenic mice as test systems and conditional control of cell death)

9. Use of Microbes in Industry and Agriculture: (8 hrs)

9.1 Production of organic compounds by microbial fermentation (ethanol, acetone/butanol, gluconic acid.)
9.2 Production of enzymes by micro-organisms (amylases, proteases)
9.3 Production of antibiotics by micro-organisms
9.3.1 Single cell proteins (SCP) from micro organisms
9.4 Biohydrometallurgy and biomineralization
9.5 Biofertilizers
9.6 Bioinsecticides
9.7 Applications of genetically engineered bacteria.

10. Intellectual Property Rights (lPR) (3 hrs)

10.1 Intellectual property
10.1.1 Intellectual property rights (patents, trade secrets, copyright, trademarks);
10.2 Plant breeder's rights (PBRs) and farmer's rights.

MODULE IV

B. Bioinformatics:

1. Bioinformatics – I: **(15 hrs)**

1.1 Biological data bases – generalized and specialized data bases- DNA, protein and carbohydrate data bases
1.2 EST, GSS, SNP and RNA databases
1.3 Nucleic acid sequence data bases
1.3.1 Premier institutes for data bases
1.3.2 Nucleic acids and amino acid codes used in database formats.

2. Bioinformatics – II: **(15 hrs)**

2.1 Sequence alignment and its evolutionary basis
2.2 Searching the database for sequence similarity
2.2.1 Search programmes with special reference to FASTA, BLAST and CLUSTAL W.
2.3 Application of bioinformatics in phylogenetic analysis.

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MSZOO02C07 - COMPARATIVEANIMALPHYSIOLOGY90 hrs

Course outcome- After completing the course the students will be able to:

- Understand the different physiological systems in animals including respiratory system, circulatory system etc.

- Have a comparative knowledge about the physiological activities in invertebrate and vertebrate animals and about how their different physiological systems evolved.
- Compare how different environments result in differences in physiological systems/activities
- Understand the basic principles and protocols of techniques and methods in physiological experiments
- Understand about nutrition and the role of different enzymes in digestion and food absorption
- Understand the diseases and disorders caused due to irregular functioning of physiological systems
- Understand the neural transmission and functions associated with it
- Understand muscle movement and its physiology
- Understand the role of endocrine glands and hormones in regulating body functions, including reproduction

MODULE 1

1. Circulation

1.1 Circulation of body fluids Cytoplasm, hydrolymph, haemolymph, lymph and blood, respiratory pigments structure and function of pigments

1.1.1 Circulatory mechanisms and fluid compartments, movement of body fluids open systems, closed system, lymph channel

1.2 Heart

1.2.1 Types of hearts, chambered hearts, tubular heart, ampular heart, lymphheart, neurogenic and myogenic heart

1.2.2 Pace makers and specialized conducting fibres

1.2.3 Cardiac cycle and cardiac output

1.2.4 Blood pressure - Neural and Chemical regulation

1.2.5 Myocardial infarction, atherosclerosis

1.2.6 ECG

1.2.7 Cerebral circulation, blood brain barrier and cerebrospinal fluids

1.2.8 Placental circulation

2. Respiration

2.1 Comparison of respiration in different animal groups [brief account only]

2.2 Anatomical considerations

2.3 Neural and chemical regulation of respiration

2.3.1 Respiratory centres

2.3.2 Factors regulating respiration

2.4 Periodic breathing

2.5 Metabolic rate

2.5.1 Basic metabolic rate and its measurement, R.Q and calculation based on it

2.6 Respiratory adjustments

2.7 Hypo ventilation, hypoxia, oxygen therapy, dyspnea, hyper ventilation, hypercapnia, respiratory buffering systems

2.8 Respiratory system in exercise

2.9 Oxygen toxicity, increased pressure of gas, decompression, inert gas narcosis

2.10 Respiration in unusual environment

2.10.1 Foetal and neonatal respiration

2.10.2 High altitude diving

MODULE 2

1. Nutrition, Digestion and Absorption:

1.1 Ruminant and non ruminant herbivory
1.2 Biochemistry of digestion and absorption of
    1.2.1 Carbohydrate
    1.2.2 Protein
    1.2.3 Fat
1.3 Liver and biliary system
1.4 Neuronal and hormonal regulation of nutritional intake
1.5 Secretion of digestive enzymes
1.6 Hunger drive and thirst.
1.7 Physiology of gastro-intestinal disorders
    1.7.1 Ulcer, Constipation
1.8 Nutritional disorders
    1.8.1 Obesity, starvation, anorexia, vitamin deficiency

2. Excretion

2.1 Comparison of excretion in different animal groups [brief account only].
    2.1.1 Osmoregulation, contractile vacuole, coelomoducts, flame cells, green glands, malpighian tubules, invertebrate nephridia
2.2 Vertebrate kidney
    2.2.1 Mechanism of tubular reabsorption and secretion
    2.2.2 Counter current mechanism
    2.2.3 Regulation of urine formation
    2.2.4 Concept of plasma clearance
2.3 Excretory products
2.4 Waste elimination, micturition
2.5 Regulation of water balance, electrolyte balance and acid base balance
2.6 Kidney disorders
    2.6.1 Acute renal failure, chronic renal failure-glomerulonephritis and pyelonephritis
2.7 Artificial kidney
2.8 Diuretic hormones.

MODULE 3

1. Nerve physiology:

1.1 Neurons, action potential;
1.2 Gross neuroanatomy of brain and spinal chord
1.3 Peripheral nervous system
1.4 Neurotransmitters and Neurohormones
1.5 Synaptic transmissions
1.6 Electrical and chemical transmission
1.7 Drug modified transmission and synaptic junction
1.8 Neural disorders
    1.8.1 Parkinson's disease, Epilepsy, Schizophrenia, Alzheimer's syndrome, Dyslexia

2. Sensory and Effecter physiology:

2.1 Structural and functional classification, modality, intensity, exteroceptors interceptors, secondary sense cells, transduction and sensory coding
2.2 Chemical senses
    2.2.1 Taste and smell
    2.2.2 Mechanism of reception
2.3 Mechanoreceptors
    2.3.1 Hair cell, organ of equilibrium

2.4 Vertebrate ear
    2.4.1 Structure; physiology of hearing
2.5 Vertebrate eye
    2.5.1 Structure; physiology of image formation
2.6 Electro and thermoreceptors
2.7 Somatic sensations
    2.7.1 Pain receptors; headache; pain suppression (analgesia) system in the brain and spinal cord

3. Muscle physiology
3.1 Skeletal muscle
    3.1.1 Ultrastructure and molecular organization
    3.1.2 Protein components of muscle (mechanism and theory)
    3.1.3 Contraction and relaxation of muscle
    3.1.4 Energetics of muscle contraction
    3.1.5 Muscle twitch, summation, tetanus, catch muscle, fibrillar muscle

MODULE 4

1. Reproductive physiology:
1.1 General pattern of reproduction
1.2 Role of hormones in reproduction in human male
1.3 Role of hormones in implantation, pregnancy, parturition and lactation in human female

2. Endocrinology:
2.1 Endocrine glands
2.2 Basic mechanism of hormone action
2.3 Neuro-endocrine regulation
2.4 Pheromones

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MSZOO02E01– IMMUNOLOGY90 hrs

Course Outcomes: After the completion of the course the student will be able to:

- Understand about the cells and organs involved in the human defense system etc.
- Acquire an in depth knowledge on the structure and functions of antibodies and the role of antigens in immune mechanism .
- Compare how different chemical messengers function in different immune status
- Use and explore several techniques and methods in conducting immunological experiments
- Understand about story of somatic gene rearrangement
- Understand different types of vaccines and their applications
- Understand the methods and issues in transplantation of organs, tissues etc.
- Understand different types of autoimmune diseases
- Learn the fundamentals of tumor immunology, different types of hypersensitivity reactions etc.

MODULE I:

1. Historical background and scope of immunology **3 hrs**

1.1. Overview of the immune system
1.2 Types of immunity
1.2.1. Innate immunity
1.2.2. Acquired immunity

2. Cells and organs of immune system **5 hrs**

2.1. Cells of the Immune system
Haematopoiesis: Myeloid lineage; lymphoid lineage; cells of immune system.
2.2. Primary lymphoid organs: Bone marrow & thymus
2.3. Secondary lymphoid organs: Lymph node, spleen & MALT

3. Cytokines and Chemokines **5hrs**

3.1. Biological functions
3.2. Families of cytokines and associated receptor molecules
3.3. Cytokine-related diseases

4. Antigens(Immunogens): **5 hrs**

4.1. Characteristic features of antigens
4.2. Factors affecting antigenecity (immunogenecity)
4.3. Epitopes & haptens
4.4. Adjuvants; role of adjuvants in enhancing immunogenicity
4.5. Superantigens

MODULE II:

5. Antibodies(Immunoglobulins): 5 hrs

5.1. Structure of a typical antibody molecule
5.2. Different classes of immunoglobulins (IgA, IgD, IgG, IgM andIgE).
5.3. Hybridoma technology: Monoclonal antibodies and their applications.

6. Organization and expression of immunoglobulin genes: 8 hrs

6.1. Primary immunoglobulin gene rearrangement
6.2. Immunoglobulin genes
6.3. The mechanism of V(D)J recombination
6.4. V(D)J recombinase
6.6. Mechanisms that generate immunoglobulin diversity

7. Complement system: 8 hrs

7.1. Classical pathway
7.2. Lectin pathway
7.3. Alternate pathways of compliment activation
7.4. Formation of membrane attack complex(MAC)
7.5. Compliment control proteins

8. Major histocompatibility complex: 8 hrs

8.1. General organization MHC class I and MHC class II
8.2. Antigen processing and presentation: Endogenous & exogenous pathways
8.3. MHC genes
8.4. Regulation of MHC expression
8.5. Functions of MHC complex

MODULE III:

9. Hypersensitivity reactions: 10 hrs

9.1. Type I hypersensitivity reactions (Allergy)
9.2. Antibody mediated (Type II) hypersensitivity reactions
9.3. Immune complex-mediated (Type III)hypersensitivity reactions
9.4. Delayed type (Type IV) hypersensitivity(DTH) reactions

10. Tolerance and auto-immunity 8 hrs

10.1. Making and breaking of self tolerance
10.2. Organ specific auto-immune disease: Hashimoto's Thyroiditis; Type 1 Diabetes Mellitus; Myasthenia Gravis
10.3. Systemic auto-immune diseases: Systemic Lupus Erythematosus; Rheumatoid Arthritis
10.4. Factors that favor susceptibility to autoimmune disease: Genetic and environmental factors.

11. Transplantation immunology 8 hrs

11.1. Graft rejection
11.2. Role of T cells in graft rejection
11.3. General immunosuppressive therapy

11.4. Specific immunosuppressive therapy
11.5. Organs amenable to clinical transplantation.

MODULE IV:

12.Vaccination **9 hrs**

12.1. Requirements for an effective vaccine.
12.2. Different types of vaccines
12.2.1.Live attenuated vaccine
12.2.2. Inactivated polypeptides as vaccines
12.2.3. Recombinant vaccines
12.2.4. DNA vaccines.

13. Immunodeficiency diseases **4 hrs**

13.1. Primary Immunodeficiencies
13.2. Secondary Immunodeficiencies

14. Tumor Immunology **4 hrs**

14.1. Tumor antigens: Tumor specific antigens and tumor associated antigens
14.2. Immune responses to cancer

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MSZOO02O01REMOTE SENSING AND GIS FOR LIFE SCIENCES 90 hrs

Module-1

1.	Introduction to GIS	2h
2.	Applications of GIS in life sciences	3h
3.	Sampling and surveying tools in GIS	5h

Module-2

1.	Finding data sources for GIS applications	5h
2.	Projections and coordinate systems	2h
3.	Data entry, Digitization, GPS using GIS software	8h
4.	Attribute queries and analysis using GIS software	5h
5.	Basic spatial analysis using GIS software	10h
6.	Checking data quality using GIS software	3h

Module-3

1.	Brief introduction to remote sensing	2h
2.	Types of remote sensing 2.1 Active 2.2 Passive	3h
3.	Remote sensing platforms	4h
4.	Satellite remote sensing and applications	5h
5.	**Application of remote sensing in life sciences**	**4h**

Module-4

1.	Remotely sensed data acquisition and pre-processing	4h
2.	Openly available remotely sensed sources of data	3h
3.	Training and classification of remotely sensed data	6h
4.	Post-processing techniques	3h
5.	Testing and validation	4h
6.	Introduction to SNAP software and Sentinel data	9h

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MSZOO02P03 - PRACTICAL - III
(CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY)

Cytogenetics:

1. Chiasma frequency studies using grasshopper testes squashes.
2. Preparation of chromosomes from rat or mouse bone marrow or human or any other lymphocyte cultures.
3. Analysis of metaphase chromosomes from rat or mouse bone marrow or any other suitable material by means of G and Cbanding.
4. Preparation of human karyotype from photographs (Xerox copies would be sufficient) of chromosome spreads – Normal and abnormal
5. Identification of human blood cell types and demonstration of drumstick on neutrophils, employing any suitable stain. Staining of human buccal epithelial smear to demonstrate Barr body.
6. Preparation and analysis of salivary gland polytene chromosomes of *Drosophila* larvae.
7. Cell fractionation and isolation of nuclei from a suitable tissue e.g., rat liver.
8. Histochemical staining of carbohydrates (PAS), Protein (Bromphenol blue), lipids (Sudan Black), DNA (Feulgen stain), DNA and RNA (Methyl Green–Pyronin)

Molecular Biology

1. Induction of chromosome aberrations in roots of *Allium cepa* or any other suitable material such as *Tredescontia* by a suitable clastogenic agent and its demonstration by means of root tip squashes.
2. Maintenance of *Drosophila melanogaster* culture. Demonstration of sex-linked inheritance by means of suitable crosses e.g., wild type with white eye color mutant.
3. Gene mapping of *Drosophila melanogaster*, using text book problems.
4. Extraction of DNA, RNA and Proteins followed by their estimation. Estimation of DNA by diphenylamine test and RNA by orcinol and protein by Lowry *et al* methods.
5. Maintenance of *E. coli* culture (Shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.
6. Isolation of genomic DNA (Isolation of DNA from cultured cells and tissues)
7. Isolation of RNA from Yeast.
8. *Drosophila* banding techniques and karyotyping.
9. Preparation of restriction fragments and their separation by electrophoresis

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MSZOO02P04 - PRACTICAL - IV
(ANIMAL PHYSIOLOGY AND PARASITOLOGY)

Animal Physiology

1. Detection of digestive enzymes in the hepatopancreas of crab.
2. Determination of Effect of temperature, on salivary amylase activity.
3. Determination of Effect of pH on salivary amylase activity.
4. Determination of Effect of substrate concentration on salivary amylase activity.
5. Diffusion of substances through intestine of frog.
6. Determination of osmotic concentration of human RBC.
7. Enumeration of human RBC.
8. Differential count of human WBC.
9. Determination of vertebrate haemoglobin using colorimetry.
10. Total and differential count of WBC
11. Effect of osmotic stress on rate of respiration.
12. Determination of salinity variations on volume/weight ratio. Nervous conduction in Arthropods.

Parasitology:

1. Preparation and uses of blood and tissue impression smears.
2. Collection and preservation of Protozoan parasites.
3. Collection and preservation of trematode parasites.
4. Collection and preservation of vector arthropods.
5. Collection and study of intra-molluscan study of trematodes from freshwater gastropods.
6. Collection and study of metacercariae from freshwater fishes and other hosts.
7. Study of medically important larval forms of insect pests.
8. Study of prepared permanent slides of parasites.
9. Collection, Preservation and identification of snail hosts of Trematode parasites.

III SEMESTER

MSZOO03C08 – DEVELOPMENTAL BIOLOGY 90 hrs

Course outcome: After completing the course, the students will be able to:

- Understand the concepts of early animal development. Also to understand the processes that lead from the fertilization of an egg cell to the formation of a well-structured and multicellular organism.
- Learn the molecular and cellular mechanisms behind the early development of organisms. Also to understand the role of the genes and proteins involved in regulating the processes of cell differentiation and determination, morphogenesis and growth.

- Get a clear idea about the paracrine factors and the main signaling pathways that play important roles in development.
- Learn the early developmental mechanisms and the genetics of axis specification involved in the development of genetic model organism *Drosophila melanogaster*.
- Have a better understanding of the hierarchy of gene activation that occurs in early Drosophila development.
- Learn and understand the early development and axis formation in amphibians such as *Xenopuslaevis* and Salamander larva.
- Describe how our eyes and arms develop in the proper locations when every cell contains identical genetic information.
- Learn how the sex of an individual is determined and its importance in sexual reproduction
- Attain knowledge about insect and amphibian metamorphosis and regeneration in various groups of animals
- Develop skills in critical thinking of developmental abnormalities leading to congenital defects due to endocrine disruptors and teratogens.
- Explain how embryonic and adult stem cells and their alternatives can be used in medical treatments.
- Students who are undertaking the practical sessions of the course is provided with experimental approaches to study the development of chick embryo and the histological preparations of different invertebrate larvae
- At the end of this course students will appreciate that the recent advances in life science are due to our in depth understanding of basic biological processes.

MODULE I:

1. Developmental dynamics of cell specification:
1.1 Autonomus specification
1.2 syncitial specification
1.3 Conditional specification; morphogenetic gradient. **6hrs**

2. Cell fate, potency, determination and differentiation. 4hrs

3. Genomic equivalence and cytoplasmic determinants, Genomic imprinting. 4hrs

4. Cell communication in development:
4.1 Induction and Competence:
4.1.1 Cascade of induction – reciprocal and sequential inductive events; instructive and permissive interactions; epithelial- mesenchymal interactions.
4.2 Paracrine factors.
4.3 Signal transduction cascades – fibroblast growth factors and RTK pathway; JAK-STAT pathway, hedgehog family; wnt family.
4.4 Juxtacrine signaling and cell patterning *eg*. *C. elegens*; the notch pathway. **10hrs**

MODULE II:

5. Gametogenesis, fertilization and early development:
5.1 Production of gametes

5.2 Cell surface molecules in sperm egg recognition
5.3 Slow block polyspermy (mammals)
5.4 Fast block polyspermy (sea urchin)
5.5 Zygote formation, cleavage, blastula, gastrulation, formation of germ layers. **10hrs**

6. Genetics of axis specification in Drosophila:
6.1 Early Drosophila development
6.2 Genes that pattern the Drosophila body plan
6.3 Primary axis formation during oogenesis
6.4 Generating dorsal-ventral pattern in the embryo
6.5 Segmentation and anterior-posterior body plan
6.6 Segmentation genes; homeotic selector genes. **10hrs**

MODULE III:

7. Early development and axis formation in amphibians:
7.1 Primary embryonic induction
7.2 Mechanism of axis determination in amphibians
7.3 Functions of the organizer
7.4 The regional specificity induction
7.5 Specifying the left right axis **10hrs**

8. Later embryonic development:
8.1 Eye Induction
8.2 Limb Development in Vertebrates
8.3 Differentiation of neurons **8hrs**

9. Sex Determination
9.1 Chromosomal sex determination in Drosophila & mammals
9.2 Environmental sex determination **6hrs**

MODULE IV:

10. Post embryonic development:
10.1 Metamorphosis; Insects and amphibians
10.2 Regeneration
10.3 Aging: senescence genes; role of free radicals; hormones and aging **8hrs**

12. Teratogenesis, Endocrine disruptors, Impacts of pesticide on development 6hrs

13. Stem cells: Embryonic stem cell; adult stem cell; medical application 8hrs

REFERENCES
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MSZOO03C09 – ECOLOGY (90 hrs)

Course outcomes: On completion of the course, students should be capable of:

- Comprehensive understanding of the basic terms, principles, rules and concepts of the ecological science
- Becoming familiar with the ecological relationships between organisms and their environment
- Understanding how earth's major ecosystems function
- Developing an understanding of the differences in the structure and function of different types of ecosystems.
- Understanding the value of these ecosystems to humans and to animals and plants
- Understanding the differentiating properties of terrestrial, aquatic and marine ecosystems and the accompanying communities;
- Having a futuristic attitude: Ability to recognize and address current environmental scenarios, scientific and technological progress, lifestyle change.
- Developing research aptitude in Ecology

MODULE I

1 Ecosystem **(14 hrs)**

1.1 Concept of the ecosystem
1.2 Properties of Ecosystem
1.2.1 Biomagnifications
1.2.2 Ecological efficiency
1.2.3 Ecological niche
1.2.4 Edge Effects & Ecotones
1.2.5 Ecocline & Ecotype
1.2.6 Ecological Equivalents.

2 Energy Concepts **(15 hrs)**

2.1 Energy flow within the Ecosystem
2.2 Laws of thermodynamics
2.3 Concept of productivity
Primary productivity; Measurement of primary production; Secondary productivity; Energy partitioning in food chains and food webs; Metabolism and size of Individuals
2.4 Decomposition
2.5 Ecological footprint
2.6 Carbon footprint

MODULE II

3 Population Ecology **(15 hrs)**

3.1 Life table
3.2 Survivorship curves
3.3 Dispersion
3.4 Concept of carrying capacity
3.5 Population fluctuation and cyclic oscillations
3.6 Population Growth curves: Sigmoid growth curve; J-shape growth curve.
3.7 Regulation of population: Density independent and density dependent mechanisms of Population regulation
3.8 r- and k- selection
3.9 Population interactions: Mutualism, Predation; Competition

4 Community Ecology **(8 hrs)**

4.1 Keystone Species,
4.2 Umbrella Species
4.3 Flagship species
4.4 Ecosystem Engineers
4.5 Diversity indices: Dominance indices; Shannon index; Simpson's index; Brillouin index; Rank Abundance; Diagrams; Jaccard Coefficient; Sorensen Coefficient; Cluster Analysis

MODULE III

5 Ecosystem Studies **(10 hrs)**

5.1 Ecology of wetlands functions, threats and management
5.2 Ecology of coral reefs: functions, threats and management
5.3 Ecology of tropical rainforest, vegetation structure, productivity and nutrient cycling, functions, threats and management

6 Climate change Ecology **(7 hrs)**

6.1 Definition
6.2 Human mediated global climate change
6.3 Climate change and ecosystem

MODULE IV

7 Ecological Modeling **(8 hrs)**

7.1 Introduction
7.2 Statistical models
7.3 Non-statistical models
  7.3.1 Analytical model
  7.3.2 Simulation model
  7.3.3 Validation of models

8 Molecular Ecology **(6 hrs)**

8.1 Concept of molecular ecology
8.2 Emergence of molecular ecology
8.3 Application of molecular ecology

9 Environmental Biotechnology (7hrs)

9.1 Bioremediation- Bioreactors for liquid waste management, biofilters, biomethanation, removal of oil spill
9.2 Ecological impacts of genetically modified organisms

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MSZOO03C10 - CONSERVATION BIOLOGY – I 90 hrs

Course outcome: After completing this course the students will be able to:

- Learn about conservation science theory and principles with examples from the field.
- Identify and understand the current threats to the biodiversity such as deforestation, fragmentation and global climate change
- Identify and evaluate the present in-situ conservation and ex-situ conservation strategies
- Analyse threats to biodiversity using molecular techniques
- Gain insights into fundamentals of conservation genetics and how it can be used as a tool for conserving and managing populations
- Identify the current problems in conservation and evaluate/explore the solutions to the problems
- Understanding the importance of including social science in conservation problem solving
- Analyse recent publications in conservation and developing complex problem solving skills in conservation
- Identify the current conservation issues in the Western Ghats biodiversity hotspot and developing skills to tackle them.

MODULE I

1. Conservation and its Importance 18 hrs

1.1 Meaning of conservation
1.2 Approaches to conservation

1.3 Conservation biology-principles
1.4 Categories for conservation status
1.5 Economic Evaluation of conservation: Cost benefit analysis; Safe minimum standard criteria

MODULE II

2. Threats to Biodiversity 30 hrs

2.1 Extinction: Current human caused mass extinction; Secondary Extinction; Extinction vulnerability
2.2 Anthropogenic impacts
2.2.1 Habitat destruction, degradation, fragmentation and loss
2.2.2 Overexploitation: Types of exploitation; Consequences of exploitation. Commercial harvesting, International Wildlife Trade
2.2.3 Global Climate Change
2.2.4 Pollution
2.3 Exotic/ Invasive species: Impacts; Success rates
2.4 Genetically Modified Organisms

MODULE III

3. Conservation of Biodiversity 16 hrs

3.1 Conservation strategies
3.1.1 In-situ conservation: Protected Areas, IUCN protected area categories, Protected area network in India
3.1.2 Ex-situ conservation: Gene banks; Germplasm banks; Seed banks; Botanical gardens; Zoos
3.2 Conservation in Captivity: Problems of captive breeding; Adaptations to captivity; Reintroduction & release.

MODULE IV

4. **Molecular techniques in Conservation 13hrs**

4.1 PCR for genotyping endangered species
4.2 RAPD as a tool of taxonomic assessment
4.3 DNA Fingerprinting – the use of satellite markers
4.4 RELP for assessment of genetic variation among individuals

5. Conservation Genetics 13 hrs

5.1 Effective population size
5.2 Small populations
5.2.1 Genetic threats to small populations: Genetic drift; Inbreeding depression; Mutational meltdown.

REFERENCES
1. Bossel, Earth at a crossroads- Path for a sustainable future. Cambridge University Press.
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3 Cunningham, P.W. and Woodworth, S. B.(1999) Environmental Science.WCB/McGraw Hill 4 Fred Van Dyke (2003) Conservation biology: foundations, Concepts, Applications. McGraw Hill.
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MSZOO03E02 –CONSERVATION BIOLOGY – II 90 hrs

Course outcome: After completing this course, the student will be able to:

- Learn about conservation biology with emphasis on its legal foundations.
- Get a strong foundation on the National laws relating to Biological Diversity

- Understand how to take Conservation biology as vocation through GOs and NGOs
- Understand the values and ethics of conservation
- Work n the emerging trends in conservation biology
- Get a clear understanding on the major issues in forest the borders- Man-animal conflict management.
- Understand the ways and means of Managing invasive populations.
- Learn the specific conservation requirements and management guidelines
- Practice the methods of conservation of Habitats and Landscapes
- Understand the practice of conservation and sustainable development at the local and national level
- Understand the restoration protocols and procedures for ecological restoration

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- Identify the current conservation issues in the Western Ghats biodiversity hotspot and developing skills to tackle them.

MODULE I:

1. The Legal Foundations of Conservation Biology 20 Hrs

1.1 UN conferences on Environment
- 1.1.1 UN Conference on Environment and Development (Rio summit) 1992
- 1.1.2 Copenhagen Climate Change Conference (Copenhagen summit) 2009

1.2 Major international conservation laws and treaties
- 1.2.1 Necessity of International cooperation
- 1.2.2 Convention on Biological Diversity
- 1.2.3 Trade-Related Aspects of Intellectual Property Rights (TRIPS)
- 1.2.4 International protection of migratory species; Bonn convention
- 1.2.5 International protection of endangered species; CITES, International Whaling Commission (IWC)
- 1.2.6 International protection of habitats and ecosystems; Ramsar Convention, World Heritage Convention, CAMLR, UNESCO Man and Biosphere Reserve Programme

1.3 National laws relating to Biological Diversity
- 1.3.1 The Biological Diversity Act 2002
- 1.3.2 Regulation of access to biological diversity (NBA, SBB, BMC)
- 1.3.3 Biological Diversity Rules, 2004
- 1.3.4 Wildlife Protection Act, 1972
- 1.3.5 Forest Conservation Act, 1980

2. Conservation in Practice 6 Hrs

2.1 People as agents of conservation
2.2 Conservation biology as vocation
2.3 Values and ethics of conservation

2.3 Emerging trends in conservation biology

MODULE II:

3. Conservation of Population 12 Hrs

3.1 Managing populations

3.1.1 Providing resources

3.1.2 Controlling threats

3.1.3 Direct manipulations; Case study of Black robin (*Petroica traversi*)

3.2 Managing meta-populations of spatially disjunct subunits; meta-population models, meta-population dynamics, conservation

3.3 Man-animal conflict management

3.4 Managing invasive populations

4. Conservation and Management of Specific Taxon 20 Hrs

4.1 Specific conservation requirements and management guidelines

4.1.1 Invertebrates: Insecta - honeybees & Arachnida - spiders

4.1.2 Fishes: Cyprinids - *Sahyadriadenisonii & Selachimorpha - Sharks*

4.1.3 Amphibians: Anura - *Nasikabatrachus sahyadrensis*& Gymnophiona - Caecilians

4.1.4 Reptiles: Cheloniidae - Olive ridley turtles & Gavialidae - Gharial

4.1.5 Birds: Bucerotidae - hornbills & Accipitridae - *Gyps* vultures

4.1.6 Mammals: *Rhinoceros unicornis* (Indian rhinoceros) &Dugong *(Dugong dugon)*

4.2 Major Wildlife conservation projects in India: Project Tiger, Gir Lion Project, Crocodile breeding project, Project Elephant

MODULE III:

5. Conservation of Ecosystems 14 Hrs

5.1 Conservation of Habitats and Landscapes: Preservation and conservation of habitats; Landscape management; Reserve design

5.2 Conservation of terrestrial Ecosystems: Forests; Grass lands; Deserts

5.3 Conservation of freshwater habitats

5.4 Conservation of marine habitats

5.5 Conservation of wetlands

MODULE IV:

6. Conservation and Human Societies 8 Hrs

6.1 Conservation and sustainable development at the local and national level

6.2 Nongovernmental organizations in conservation: Regional, National and International

6.3 Traditional societies, conservation and sustainable use

7. Restoration Ecology 10Hrs

7.1 Definition and development

7.2 Restoration protocols and procedures for ecological restoration
7.3 Restoring terrestrial and aquatic ecosystem
7.4 Restoration in urban areas
7.5 Biocultural restoration

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MSZOO03E03- WILDLIFE BIOLOGY90 hrs

Course outcome: After the completion of the course the students will be able to:

Understand the biodiversity with emphasis on various groups of animals
Understand the significance of the Western Ghats as atreasure trove of biodiversity with higher level of endemism.
Recognize different groups of wild animals at least upto family level.
Inculcate a research culture, especially in the field of taxonomy and biodiversity.
Equip themselves to propogate the message of conservation of animals and their ecosystem
Create awareness among the public about the ecosystem services of living creatures

MODULE I & II

1. Introduction **10 hrs**

Biodiversity: Definition
Kinds of biodiversity
Biodiversity hotspots
Endemism
Western Ghats Biodiversity

2. Biology and Taxonomy of Mammals **30 hrs**

Biology and Taxonomy of the following animals with special emphasis on Western Ghats (Biology should include population status, distribution, feeding and breeding habits, major threats to their survival and

conservational significance)
Mammals
Order Primates
Apes: Gibbon
Monkeys: Macaques (Bonnet, Rhesus, Assamese and Lion tailed) Langurs (Common, Capped, Golden, Nilgiri) Lemurs: Slender Loris and Slow Loris Order Carnivora
Cats: Tiger, Lion, Leopard, Fishing cat, Leopard cat, Jungle cat, Indian Wild Dog, Wolf, Jackal, Indian Fox Otters: Common Otter, Smooth Indian Otter
Bears: Sloth bear, Brown bear, Himalayan black bear, Sun bear Panda: Giant panda, Red panda
Hyena: Striped hyaena
Civets: Malabar civet, Small Indian civet, Common palm civet
Mongoose: Common mongoose, Small Indian mongoose, striped necked mongoose Order Artiodactyla
Cervids: Chital, Sambar, Barking deer, Mouse deer.
Bovids: Indian Antelope, Four horned Antelope, Nilgiri Tahr, Indian bison. Suids: Indian Wild boar.
Order Proboscidae Indian Elephant
Order Perisodactyla One horned Rhinoceros. Order Pholidota Indian Pangolin
Order Lagomorpha Hispid hare
Order Insectivora Tree shrew, Hedgehog
Order Rodentia Indian Giant squirrel, Grizzled giant squirrel, Porcupine, Flying squirrel, striped palm squirrel Order Chiroptera Indian flying fox, Short nosed fruit bat, Indian pipistrella
Order Cetacea Gangetic dolphin, Common dolphin, Sperm Whale. Order Sirenia Sea cow

MODULE III

3. Biology and Taxonomy of Birds **20 hrs**

Habitat preference
Flocking and aggregation.
Foraging behaviour,
Food competition and selection
Courtship and pair selection,
Brood parasitism and cooperative breeding.
Vocalisation and its Role in birds
Flyways and peculiarities of bird migration in the Indian Subcontinent
Avian classification and distribution with special reference to Indian species.
Order Columbiformes Blue Rock pigeon, Spotted Dove.
Order Podicipediformes Little Grebe
Order Pelecaniformes Little and Large Cormorant, Darter
Order Ciconiformes Pond heron, Large egret, Little egret, Median egret, Grey heron, Purple heron Order Ansariformes Bar headed goose, Lesser whistling teal
Order Gruiformes Indian Moorhen, Purple moorhen, White breasted water hen
Order Charadriformes River tern, Red wattled Lapwing, Yellow wattled Lapwing, Black headed gull, Bronze winged jacana, Pheasant tailed jacana.
Order Falconiformes Hawks, Vultures.
Order Gruiformes Indian cuckoo, Koel, Crow pheasant
Order Coraciformes White breasted kingfisher, Small blue kingfisher,
Pied kingfisher, Brown headed kingfisher, Chestnut headed Bea eater, Small green Bea eater, Hornbills
Order Pisciformes Lesser Golden backed woodpecker, Indian golden backed woodpecker, Small green barbet Order Psittaciformes Rose ringed parakeet, Blossom headed parakeet, Lorikeet
Order Strigiformes Indian horned owl, Mottled wood owl, Barn owl Order Apodiformes Palm swift
Order Passeriformes Black headed Oriole, Golden Oriole, Tree Pie,
Drongo, Racket tailed Drongo, Red whiskered Bulbul, Red vented Bulbul, Black headed Babbler, White headed Babbler, Munia, Magpie Robin, Jungle Babbler, Purple sunbird, Purple rumped sunbird, Indian Roller, Indian Robin, White cheeked Bulbul, Tickell's flower pecker, Thick billed flower pecker, Paradise

flycatcher.
Globally endangered Indian birds and their classification (At least 20species).
Endemic Indian birds and endemic bird areas.
Economic importance of birds- beneficial and harmfulrole.

MODULE IV

4. Fishes, Amphibians &Reptiles **20 hrs**

Fishes: Endangered and Endemic fishes of Western Ghats (Brief account with threat to their survival).

Amphibia: Amphibians endemic to Western Ghats (Brief account with threat to theirsurvival)

Reptiles

Order Crocodilia Gharial, Estuarine crocodile, Marsh crocodile.

Order Testudines Logger headed sea turtle, Green Sea Turtle, Hawk's Bill Turtle, Olive Ridley Turtle, Leatherback Sea Turtle. (Brief account with threat to their survival)

Order Squamata Indian Monitor Lizards (Brief account only)

Endangered and endemic snakes of Western Ghats (Brief account only)

5. Sociobiology &Territoriality **5 hrs**

Sociobiology of Lion, Elephant and Deer

Territoriality and functions of territory.

6. Principles &Hypothesis **5 hrs**

Gondwana principle

Satpura Hypothesis

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17. Trothy, J.B. Boyle and Boontawee – Measuring and monitoring Biodiversity in Tropical and Temperate Forest. Centre for International forestry Research, Bogor, Indonesia

MSZOO03O02 Statistics for Biologists

Module-I

1. Probability
2. Theoretical probability distributions
3. A brief introduction to descriptive, inferential and correlational statistics
4. Statistical testing

Module-II

1. Introduction to data science
2. Introduction to SPSS software
3. Data entry, structure and manipulation
4. Descriptive statistics in SPSS
   - 4.1 Mean
   - 4.2 Median
   - 4.3 Mode
   - 4.4 Standard deviation
   - 4.5 Standard error
   - 4.6 Range
5. Test for normality in SPSS
6. Inferential statistics in SPSS
   - 6.1 Parametric statistical tests
     - 6.1.1 One sample T-test
     - 6.1.2 Two sample T-test
     - 6.1.3 Paired T-test
     - 6.1.4 Chi-squared test
     - 6.1.5 ANOVA (Analysis of variance)
   - 6.2 Non-parametric statistical tests
     - 6.2.1 Mann-Whitney U test
     - 6.2.2 Kolmogrov-Smirnov test
     - 6.2.3 Wilcoxons signed rank test
     - 6.2.4 Kruskal-Wallis H test
     - 6.2.5 Friedman test
7. Correlational statistics in SPSS
   - 7.1 Correlation
   - 7.2 Linear regression
   - 7.3 Logistic regression

Module-III

1. Introduction to R software
2. Data entry and data formats
3. Data structure and manipulation
4. Statistical packages and its application in R

Module-IV

1. Graphical representation of data in MS excel and R.
   - 1.1 Bar plot
   - 1.2 Clustered plots
   - 1.3 Scatter plot
   - 1.4 Histogram
   - 1.5 Box plots

MSZOO03P05 – PRACTICAL - V (DEVELOPMENTAL BIOLOGY)

1. Induced ovulation in fish/frog
2. Effect of bilateral eyestalk ablation on moulting in the crab *Barytelphusa cunicularis.*
3. Ovarian index under de-eye stalking of a crustacean.
4. Collection, preservation and permanent preparation of invertebrate larval forms (any five)
5. Rearing of amphibian embryo & larvae and identification of different developmental stages.
6. Vital staining of chick embryo.
7. Histological preparation of chick embryo (any two stages).
8. Preparation of permanent/temporary stained whole mounts of chickembryo.
9. Sperm count of frog
10. Regeneration study on amphibian tadpole

MSZOO03P06 – PRACTICAL - VI (ECOLOGY & CONSERVATION BIOLOGY)

1. Identification of marine plankton.
2. Separation and Identification of soil micro arthropods applying Berlese funnel
3. Sampling methods: Pitfall traps, Line transect, Quadrate sampling, Point quarter sampling
4. Intertidal studies: rocky shores, sandy (marine) shore, muddy shore and estuaries.
5. Estimation of salinity, pH, phosphates, chlorides and silicates in water samples.
6. Estimation of dissolved oxygen
7. Determination of dissolved Carbon dioxide

IV SEMESTER

MSZOO04E04– RESEARCH METHODOLOGY- CONCEPTS&METHODS90 hrs

Course outcome: After completing this course, students will be able to

- Understand what research is and how to go ahead in scientific research
- Learn remote sensing techniques and its applications in animal ecology and behaviour studies
- Learn GIS and its applications in animal ecology and behaviour studies
- Hands on experience in scientific writing and communication.
- Learn about the Ethical, Legal, Social and Scientific Issues in Biological Research
- Identify literature for scientific article, report, thesis preparation etc.
- Understand open access publishing
- Learn about fundamentals of open source software like R, Python, Q GIS etc.
- Prepare and preserve museum specimens for display
- Learn about taxidermy and Museology

I. Introduction 12 Hrs

1. Meaning of research
2. Motivation for research
3. Types of research
4. Approaches in research

5. Research methods and research methodology
6. Research process
7. Problems encountered by researchers in India.

II. Defining Research Problem 8Hrs
1. What is a research problem?
2. Selecting research problem
3. Techniques in defining research problem.

III. Research Design 10 Hrs
1. Meaning of research design
2. Features of a good research design
3. Important concepts relating to research design
4. Different research designs
5. Basic principles of experimental designs.

IV. Scientific Writing and publishing 14 Hrs
1. Different steps in scientific writing
2. Layout of research reports/thesis
3. Types of reports: Research papers, popular science articles; dissertation/thesis
4. Oral presentation.
5. Open access publishing
6. Open source software

V. Ethical, Legal, Social and Scientific Issues in Biological Research 12Hrs
1. Guidelines for biosafety
2. Functioning of Institutional Animal Ethics Committee and Institutional Ethics Committee
3. CPCSEA guidelines for experimentation
4. DBT guidelines for biosafety practices.

VI. Research Project Proposals and Funding Agencies 12 Hrs
1. Preparation of research project proposal
2. Project funding agencies – DST,UGC,DBT,CSIR,KSCSTE,KFRI and KSBB.

VII. Remote sensing: Applications; GIS 6 Hrs

VIII. Digital photography and Videography; photomicrography. 8Hrs

IX. Taxidermy and Museology 8Hrs

References:

1. Slayter, E.M. (1970) Optical methods in biology. Wiley Inter-science
2. Daniel, M. (2002) Basic biophysics for Biologists, Agro botanica, Bikaner
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6. Nolting, B, (2003) methods in modern biophysics, Springer, Berlin
7. Gautham, N.V.P. (2003) Biophysics. Narosa Publ. house, N. Delhi.
8. Biological Techniques:
9. Richard Dawkins (2008). Modern Science Writing. Oxford University Press
10. Paul Oliver (2008). Writing your thesis. Sage Publications.
11. Ranjith Kumar (2008). Research Methodology (4th edn). PearsonEducation

12. Michael R Peres (2007). Focal Encyclopedia of Photography.Elsevier
13. Liz Hamp-Lyons & Ben Heasly (2008) Study writing. Cambridge University Press.

MSZOO04E05 PARASITOLOGY 90Hrs

A. General Parasitology (30 hrs)

1. Introduction to Parasitology 5 Hours
   1.1. Parasitology and human and animal welfare
   1.2. Types of parasites and hosts
   1.3. Transmission of parasites

2. Parasitic adaptations: 6 Hours
   2.1 Morphological
   2.2. Physiological
   2.3. Biochemical
   2.4 Immunological.

3. Ecology of parasites: 8 Hours modify
   3.1 Epidemiology
   3.2 Ecosystem and parasites
   3.3. Host demography
   3.4 Ecological terms in Parasitology
   3.5 Parasitic Zoonoses

4. Behaviour and Parasitism: 6 Hours
   4.1 Parasite effects benefitting parasites
   4.2 Counter measures of hosts
   4.3 Parasitism and life history theory

5. Effects of parasites on hosts: 5 Hours
   5.1 Parasite induced modifications of host
   5.2 Growth factors
   5.3 Parasitic castration
   5.4 Effects of toxins, poisons and secretions

B. Protozoology (15 Hours)

6. Morphology, life cycle, pathology and prophylaxis of the following protozoan parasites:
   6.1 Phylum Mastigophora- *Leishmania*
   6.2 Phylum Sarcodina – *Entamoeba*
   6.3 Phylum Ciliophora – *Balantidium*
   6.4 Phylum Apicomplexa – *Plasmodium*
   6.5 Phylum Myxozoa – *Myxosoma*
   P6. Phylum Microspora – *Nosema*

C. Helminthology (25 Hours)

7. Morphology, life cycle, pathology and prophylaxis of the following Trematode, Cestode and Nematode parasites:
   7.1 Digenetic trematodes: *Schistosoma, Fasciola, Paragonimus*,. (an account on larval trematodes with emphasis on classification of cercariae) 10 Hours
   7.2 Cestodes: *Diphyllobothirum, Taenia, Echinococus* 6 Hours
   7.3 Nematodes: *Ancylostoma, Ascaris, Enterobius , Wuchereria* 7 Hours

8. Freshwater gastropod molluscs as intermediate hosts of trematode parasites 2 Hours

D. Arthropods of Medical and Veterinary importance. 15 Hours

9. Morphology, life cycle, medical & veterinary importance and control measures of the following arthropods:
   - 9.1 Insects: *Phlebotomus, Anopheles, Culex, Aedes, Ctenocephalides, Xenopsylla, Pediculus*
   - 9.2 Arachnids: *Boophilus, Sarcoptes*
10. Myiasis : Definition, types and medical & veterinary importance

E. Molecular taxonomy of parasites: 5 Hours

Parasitology:

1. Gerald W. Esch. (2016). Ecological Parasitology. Wiley Blackwell.
2. Elling Ulvestad (2007) - Defending Life -The nature of host-parasite relations. Springer
3. Michel Serres (2007) The Parasite. University of Minnesota Press
4. Joanne P. Webster (Eds.) (2009). Natural History of Host-Parasite Interactions
5. Serge Mor and Boris R Krasnov
6. Cheng TC (1986): General Parasitology, Academic Press, N.Y.
7. Cox FEG (1993): Modern Parasitology – a text book of Parasitology, Blackwell Scientific, London.
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25. Gillespie's, SH & Hawkey PN (1995): Medical Parasitology – A practical approach, Oxford Univ. Press.
26. Roberts, LS and J Janovy (2006): Foundations of Parasitology (McGraw Hill) Bush A O, et al. (2001): Parasitism – The diversity and ecology of Animal Parasites.

MSZOO04E06- FISHERIES BIOLOGY 90 Hours

1. Fish Taxonomy **5 hrs**

Classification and distribution of economically important fin fishes

2. Integument **6 hrs**

Exoskeleton
Skin and scales
Colouration
Chromatophores and pigments
Structure, function and modification offins

3. Locomotion **5 hrs**
Body shape and musculature
Mechanism of propulsion

4. Life history of fishes **8 hrs**
Reproduction, reproductive hormones, reproductive behaviour, oviparity, ovoviviparity
Age and growth
Migration

5. Digestive physiology **8 hrs**
Food and feeding
Feeding behaviour
Feeding mechanism
Digestive enzymes
Absorption

6. Circulatory physiology **6 hrs**
Heart
Blood, blood cells, blood pigments and functions of blood
Circulation

7. Respiratory physiology **6 hrs**
Gills and Accessory respiratory organs
Gas transport

8. Excretory and Osmoregulatory physiology **6 hrs**
Excretoryorgans
Osmoregulation in marine, brackish water and fresh water fishes

9. Endocrinephysiology **10 hrs**
Endocrine glands – structure and function
Regulation of endocrine secretion
Crustacean neurosecretory system and their role in reproduction

10. Adaptive physiology **7 hrs**
Deep sea fishes
Cave dwelling fishes
Hill stream fishes

11. Oceanography **10 hrs**
Ecological subdivisions of the sea
Major topographic features of continental shelf, continental slope and ocean floor
Physico-chemical properties of seawater
Ocean currents
Ocean productivity
Coral reefs

12. Brackish water ecology **7 hrs**

Characteristics of brackish and estuarine waters
Estuarine productivity

13. Limnology **6 hrs**

Classification of inland waters – ponds, lakes, rivers andreservoirs
Physico-chemical properties of inlandwaters

References:

1. Jayaram K. C. 2002. Fundamentals Of Fish Taxonomy. Edition, reprint. Publisher, Narendra Publishing House. Original from, CornellUniversity.
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8 Wetzel, R.G. Limnology. W.B. Saunders Co.,1975.
9 Sedgewick. A Student's textbook of Zoology, Vol. I &II.
10 Usinger. General Zoology, Vols. I &II.
11 Marshall & Williams. Textbook of Zoology.Vol.I.
12 Parker and Hasswell. Textbook of zoology, Vertebrates. Vol.II. 13 Barnes. General Zoology
14. Day, F. The fishes of India.
15. S.S. Khanna. An introduction to fishes
16. K.G. Lagler. Ichthyology
17. Prosser & Brown. Comparative Physiology
18. Hoar. Comparative Physiology
19. Hoar & Randall. Fish Physiology

MSZOO04C11 PROJECT WORK

The main objective of introducing a project work in the curriculum is that the student who completes this course should get hands on experience in independent research work in the field of biodiversity conservation and management. He/she should equip himself/herself to face challenges in Conservation Biology and should be able to provide trained manpower in the field. A topic in the optional subject – Biodiversity: Conservation and Management shall be assigned to each student.

The research work related to this topic will be carried out by each student under the supervision of a teacher. The report of the findings shall be submitted by each student in the form of a dissertation which shall be submitted for evaluation a day prior to the date of viva voce examination of the fourth semester. A declaration by the student to the effect that the dissertation submitted by him/her has not previously formed the basis for the award of any degree or diploma and a certificate by the supervising teacher to the effect that the dissertation is an authentic record of work carried out by the student under his supervision are to be furnished in the dissertation.

Assessment of different components of project may be taken as below:

Internal evaluation: 80 marks

Internal evaluation should be done by the Internal supervising teacher on the basis of the involvement of student at various stages of the project work including collection of data in a time bound manner, submission of dissertation as per the time schedule and on the sincerity and punctuality in carrying out the dissertation work

External evaluation: 120 marks

External evaluation of the dissertation and the conduct of Viva Voce examination should be done by two examiners of which one should be an expert from an Academic or research institute from a panel of experts submitted to University by the Head of the Department and the other should be a permanent faculty member nominated by the Head of the Department.

Out of the 120 marks 80 marks may b earmarked for the dissertation, 30 marks for the presentation and 10 marks for the interaction

Pass conditions. The students shall declare to pass the project report course if she/he secures a minimum of 40% marks (internal and external put together). In an instance of inability of obtaining a minimum of 40% marks, project work may be redone and the report may be resubmitted along with subsequent exams through parent department. There shall be no improvement chance for the marks obtained in the project report.

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