SACRED HEART COLLEGE
Autonomous

CURRICULUM AND SYLLABI

CREDIT SEMESTER SYSTEM (CSS)

M.Sc. ZOOLOGY PROGRAMME

INTRODUCED FROM 2020 ADMISSION ONWARDS

Prepared By

BOARD OF STUDIES IN ZOOLOGY

Sacred Heart College, Thevara, Kochi, Kerala

Report of the Board of Studies

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The BOS meeting held on 25/07/2017, Thursday at 3 pm in the department discussed and approved the final revised syllabus for the M. Sc. Zoology Programme wef 2020- 2021 admissions.

CONTENTS

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2020

1. Title

These regulations shall be called ' **REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2020'**

2. Scope

Applicable to all Post Graduate (PG) programmes of the college with effect from 2020-21 admissions. The provisions herein supersede all the existing regulations for the Post Graduate programmes of the college.

3. Programme Specific outcomes (PSOs) for the M.Sc. Zoology Postgraduate students of Sacred Heart College, Kochi.

At the end of the programme, the students will

1. Understand the advanced concepts of life at different levels of biological organization, from gene to genome, cell, tissue, organ, organ-systems and whole organisms; and drawing upon this knowledge, understand physiological adaptations, development, reproduction, behaviour and evolution of different forms of life.
2. Understand the ecological interconnectedness of life on earth; to relate the physical features of the environment to the structure of populations, communities and ecosystems; and analyse the various environmental issues for providing scientifically sound and socially acceptable solutions.
3. Demonstrate proficiency in experimental techniques and methods of analysis appropriate for different branches of biology with scientific temperament and problem-solving attitude.
4. Develop aptitude and skills in research in different branches of Zoology and in careers related to teaching in Zoology; as well as in having innovative ideas and necessary training to initiate unique start-ups and entrepreneurship in the realm of life sciences.

4. Definitions

i. '**Programme**' means the entire course of study and examinations.

ii. 'Duration **of Programme'** means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be of 4 semesters and M Phil programmes shall be 2 semesters.

iii. **'Semester'** means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days, each with 5 contact hours of one hour duration

iv. **'Course'** means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork/ study tour /seminar / project / practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

v. **'Credit' (Cr)** of a course is the numerical value assigned to a course according to the relative importance of the content of the syllabus of the programme.

vi. '**Extra credits**' are additional credits awarded to a student over and above the minimum credits required for a programme

vii. '**Programme Credit'** means the total credits of the PG/M Phil Programmes. For PG programmes the total credits shall be 80 and for M.Phil. it shall be 40.

viii. **'Programme Elective course'** Programme Elective course means a course, which can be chosen from a list of electives and a minimum number of courses is required to complete the programme.

ix. '**Programme Project'** Programme Project means a regular project work with stated credits on which the student undergoes a project under the supervision of a teacher in the parent department / any appropriate Institute in order to submit a dissertation on the project work as specified.

x. '**Internship**' is on-the-job training for professional careers.

xi. '**Plagiarism**' Plagiarism is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

xii. '**Seminar'** seminar means a lecture by a student expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation. xiii. '**Evaluation'** means every course shall be evaluated by 25% continuous (internal) assessment and 75% end course/end semester (external) assessment.

xiv. '**Repeat course'** is a course that is repeated by a student for having failed in that course in an earlier registration.

xv. **'Audit Course'** is a course for which no credits are awarded. xvi. '**Department'** means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.

xvii. '**Department Council'** means the body of all teachers of a Department in a College.

xviii. **'Faculty Advisor'** is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.

xix. '**College Co-ordinator** means a teacher from the college nominated by the College Council to look into the matters relating to CSS-PG System. xx. **'Letter Grade'** or simply '**Grade**' in a course is a letter symbol (O, A, B, C, D, etc.) which indicates the broad level of performance of a student in a course.

xxi. Each letter grade is assigned a **'Grade point'** (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

xxii. **'Credit point'** (CP) of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course CP=GP x Cr.

xxiii. '**Semester Grade point average'** (SGPA) is the value obtained by dividing the sum of credit points (CP) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester . The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxiv. **Cumulative Grade point average'** (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places.

xxv. '**Grace Marks'** means marks awarded to course/s, as per the orders issued by the college from time to time, in recognition of meritorious achievements in NCC/NSS/Sports/Arts and cultural activities.

5. ATTENDANCE

Being a regular college, physical presence in the regular activities, especially, classes and exams, is mandatory for the students. However, if a student secures 75% of attendance he/she is eligible to appear for the exams, provided there are no other impediments like disciplinary proceedings, malpractice record etc.

i. **Absence:** A student found absent for one hour in the forenoon or afternoon session is deprived of the attendance for the entire session as far as eligibility for final exam is concerned. ii. The hour related calculation in a course is meant for awarding marks for the course concerned, where applicable.

iii. **Late entry**: A student is supposed to be in time for the class. Late arrival related treatment is left to the discretion of the individual teacher. However, as a norm, a late arriving student may be permitted to the class, if it is not

inconvenient or distraction to the class as such; though attendance MAY NOT BE GIVEN. Late arrival beyond 5 minutes is treated as ABSENCE; though the teacher may consider permitting the student to sit in the class. iv. **Leave** : A student has to formally report his/her absence with reasons either in advance, or immediately after the absence for obtaining an approved leave. This applies to all sorts of leave – medical, on duty or other.

v. The student is supposed to report in prescribed format on the very next day of the absence; however, up to a week's time is permitted. Afterwards, the leave applications will not be considered.

vi. The student has to retain a copy/section of the approved leave form and produce the same as proof, in case there is any confusion regarding the leave sanctioning. In the absence of such proof, the claims will not be entertained.

vii. **Duty Leave**: A student representing the college in sports, arts, social service or academic matters, has to get sanction from the class teacher concerned and submit the leave application form duly endorsed by the class teacher and Head of the department, and submit it to the Vice Principal. The same will be forwarded by the Vice Principal for attendance entry. **SPORTS**: The approval of the Department of Physical Education and the class teacher is required. The time limit for submission mentioned above is applicable in the case of duty leave as well.

viii. **Condonation**: A student may have the privilege of condonation of attendance shortage (up to a maximum of 10 days) on the basis of genuineness of the grounds of absence (medical reasons or college duty), duly recommended by the department. This is not a matter of right. It is a matter of privilege based on Principal's discretion and the good conduct of the student on the campus. A student of PG programme may have only one such opportunity.

ix. **Re-admission**: A student whose attendance is inadequate will have to discontinue the studies. Such students, whose conduct is good, may be readmitted with the approval of governing council, on the basis of recommendation from the department, and assurance from the student and the guardian regarding good conduct and compliance in academic and discipline matters. For this the prescribed re-admission fee has to be paid.

As a condition for re-admission, the student should have cleared all academic arrears, or should have appeared for the exams in which he/she is having an arrear (if the results are not out), and should have fulfilled all academic assignments prescribed by the department for compensating for his lack of attendance.

x. **Unauthorised absence & removal from rolls**: A student absent from the classes continuously for 10 consecutive working days without

intimation or permission, shall be removed from the rolls, and the matter intimated to the student concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

5. PROGRAMME REGISTRATION

i. A student shall be permitted to register for the programme at the time of admission. ii. A PG student who registered for the programme shall complete the same within a period of 8 continuous semesters from the date of commencement of the programme.

6. PROMOTION: A student who registers for the end semester examination shall be promoted to the next semester. However, in extreme circumstances, a student having sufficient attendance who could not register for the end semester examination may be allowed to register notionally by the Principal with the recommendation of the Head of the department concerned and, by paying the prescribed fee.

7. EXAMINATIONS

All the End Semester Examinations of the college will be conducted by the Controller of Examination. The Principal will be the Chief Controller of Examinations. An Examination committee consisting of the Chief Controller of Examinations, Controller of Examinations, Additional Chief Superintendent, Deans, IQAC Coordinator and other faculty members nominated by the Principal will act as an advisory body on the matters relating to the conduct of examinations.

8. EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts;

a. Continuous Internal Assessment (CIA) and

b. End Semester Examination (ESE).

The internal to external assessment ratio shall be 1:3, for both courses with or without practical. For all courses except the courses offered by the school of communications, there shall be a maximum of 75 marks for external evaluation and maximum of 25 marks for internal evaluation. In the case of courses offered by the school of communications, the internal to external assessment ratio shall be 1:1. (In their cases, the components for evaluation and their respective marks shall be determined by their Board of Studies). Both internal and external evaluation shall be carried out in the mark system and the marks are to be rounded to the nearest integer.

a. **Continuous Internal Assessment (CIA)/ Continuous Assessment**: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars/viva/field study/industrial visits/study tour etc. with respect to theory courses and based on written tests, lab skill/records/viva voce etc. with respect to practical courses. The marks assigned to various components for internal evaluation as follows.

Components of Internal Evaluation (for theory)

	Components	**Marks**
i.	Assignments	5
ii	Seminar	5
iii	Quiz/Field study/Industrial Visit/Viva Voce/Study Tour/etc.	5
iv	Two Test papers(2x5)	10
	Total	25

i. **Assignments**: Every student shall submit one assignment as an internal component for every course.

Components	**Marks**
Punctuality	1
Content	2
Conclusion	1
Reference/Review .	1
Total	**5**

ii. **Seminar**: The seminar lecture is expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

Components	**Marks**
Content	2
Presentation	2

Reference/Review	1
Total	**5**

iii. A quiz or viva or field survey or any suitable method shall be used by the course teacher to assess the students and a maximum of 5 marks shall be awarded for this component

iv. **Class Tests**: Every student shall undergo two class tests as an internal component for every course.

Components of Internal Evaluation (for practical)

Components	Marks
Laboratory Involvement	5
Written/ Lab Test (2X5)	10
Record	5
Viva Voce	5
Total	25

b. End Semester Examination (ESE): The End Semester Examination in theory courses shall be conducted by the college with question papers set by external experts/ question bank. The evaluation of the answer scripts shall be done by the examiners based on a well-defined scheme of evaluation given by the question paper setters/Prepared as per the direction of the Chairman, Board of Examiners. The evaluation of the End Semester Examinations shall be done immediately after the examination preferably through the centralised valuation.

c. Project

Project work is a part of the syllabus of most of the programmes offered by the college. The guidelines for doing projects are as follows:

i. Project work shall be completed by working outside the regular teaching hours.

ii. Project work shall be carried out under the supervision of a teacher in the concerned department or an external supervisor.

iii. A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization/ Institute on the recommendation of the Supervisor. iv. There should be an internal assessment and external assessment for the project work in the ratio 1:3

v. The external evaluation of the project work consists of valuation of the dissertation (project report) followed by presentation of the work and viva voce.
vi. The mark and credit with grade awarded for the program project should be entered in the grade card issued by the college.

Components of Internal Evaluation for Projects

Components	**Marks**
Topic/Area selected	2
Experimentation/Data collection	5
Punctuality-Regularity	3
Compilation	5
Content	5
Presentation	5
Total	**25**

Vii **Components of External Evaluation for Projects**

Components	**Marks**
Topic/Area selected	5
Objectives	10
Experimentation/Data collection	15
Content/Analysis	20
Presentation	10
Conclusions/Findings/Summary	10
Reference	5
Total	**75**

d. Comprehensive Viva-voce

Comprehensive Viva-voce shall be conducted at the end of the programme, which covers questions from all courses in the programme as per the syllabus.

e. Grade and Grade Points

For all courses (theory & practical), Letter grades and grade point are given on a 10-point scale based on the total percentage of marks, (CIA+ESE) as given below:-

Percentage of Marks	Grade	Grade Point (GP)
95 and above	O Outstanding	10
85 to below 95	A^+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B^+ Good	7
55 to below 65	B Above Average	6
45 to below 55	C^+ Average	5
40 to below 45	C Pass	4
Below 40	F Fail	0
	Ab Absent	0

Grades for the different semesters and overall programme are given based on the corresponding SGPA/CGPA as shown below:

SGPA/CGPA	Grade
Equal to 9.5 and above	***O Outstanding***
Equal to 8.5 and below 9.5	***A+ Excellent***
Equal to 7.5 and below 8.5	***A Very Good***
Equal to 6.5 and below 7.5	***B+ Good***
Equal to 5.5 and below 6.5	***B Above Average***
Equal to 4.5 and below 5.5	***C + Average***
Equal to 4.0 and below 4.5	***C Pass***
Below 4.0	***F Failure***

A **separate minimum of 40% marks** required for a pass for both internal evaluation and external evaluation for every PG programme.

A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the end semester examination for the same semester, subsequently. A student who fails to secure a minimum marks/grade for a pass in a course can be permitted to write the examination along with the next batch.

After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of semester, a student should pass all courses and score at least the minimum CGPA grade **'C'**.

However, a student is permitted to move to the next semester irrespective of her/his SGPA.

Credit Point (CP) of a course is calculated using the formula

CP = Cr x GP, where Cr = Credit; GP = Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula

SGPA = TCP/TCr, where

TCP = Total Credit Point of that semester $= \sum^{n}_{1} \mathrm{CPi}$**;**

TCr = Total Credit of that semester $= \sum^{n}_{1} \mathrm{Cri}$

Where n is the number of courses in that semester

Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula

CGPA $= \sum(\mathrm{SGPA} \times \mathrm{TCr}) / \sum \mathrm{TCr}$

SGPA/CGPA shall be round off to two decimal places

To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board/website at least one week before the commencement of external examination. There shall not be any chance for improvement for internal mark.

The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the controller of examinations through the Head of the Department and a copy should be kept in the department for at least two years for verification.

PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard, application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He/She shall also submit a detailed scheme of evaluation along with the question paper.

A question paper shall be a judicious mix of, short answer type, short essay type /problem solving type and long essay type questions.

Pattern of questions for external examination for theory paper

Type of Questions	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Section A – Short Answer	12	8	2	16
Section B- Short essay/ Problems	10	7	5	35
Section C- Long essay	4	2	12	24
	26	**17**		**75**

Pattern of questions for external examination of practical papers will be decided by Practical exam board chairman as per the guidelines of Board of Studies.

9 Admission

The eligibility criteria for admission to all PG programmes shall be published by the college along with the notification for admission.

10 Registration for the examination

a. All students admitted in a programme with remittance of prescribed fee are eligible for the forthcoming semester examinations.
b. Online application for registration to the various End Semester Examinations shall be forwarded to the CE along with prescribed fee for each course in prescribed format.
c. The eligible candidates who secure the prescribed minimum attendance of the total duration of the course and possess other minimum qualification prescribed in the regulations for each course shall be issued the hall tickets. The hall ticket shall be downloaded by the students from the college website.
d. The mode of fee remittance shall be through the prescribed bank.

11 Supplementary Examinations

Candidates who failed in an examination can write the supplementary examination conducted by the College along with regular examinations.

12 Improvement of Examination

There will be no improvement examinations for PG programmes

13 Promotion to the Next Higher Semester

A candidate shall be eligible for promotion from one semester to the next higher semester if,

a. He / she secures a minimum 75 % attendance and registered for the End Semester Examination of the programme for which he/she is studying.
b. His / her progress of study and conduct are satisfactory during the semester completed, as per the assessments recorded by the course teachers and the Head of the Department concerned.

14. **Certificates**

1. Diploma and Degree certificates are issued by the Mahatma Gandhi University, Kottayam as per the act and statues of the University on the submission of the consolidated mark / score cards of the students by the College.
2. A consolidated mark / scored card shall be issued to the candidates after the publication of the results of the final semester examination taken by the candidate.
3. A Course Completion Certificate with classification shall be issued to students till the provisional certificate is issued by the university.

15. **Award of Degree** The successful completion of all the courses with ‘C ’ grade shall be the minimum requirement for the award of the degree.

16. **Monitoring**

There shall be a Monitoring Committee constituted by the Principal consisting of faculty advisors, HoD, a member from teaching learning evaluation committee (TLE) and the Deans to monitor the internal evaluations conducted by college. The Course teacher, Class teacher and the Deans should keep all the records of the internal evaluation, for at least a period of two years, for verification.

Every Programme conducted under Credit Semester System shall be monitored by the College Council under the guidance of IQAC Coordinator, Controller of Exams, academic Deans and HoDs. An academic committee consisting of the Vice Principal, Deans and teachers nominated by the Principal shall look after the day-to-day affairs of these regulations.

17. **Grievance Redressal Mechanism**

In order to address the grievance of students regarding Continuous internal assessment (CIA) a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

Level 1: At the level of the concerned course teacher

Level 2: At the level of a department committee consisting of the Head of the Department, a coordinator of internal assessment for each programme nominated by the HoD and the course teacher concerned.

Level 3: A committee with the Principal as Chairman, Dean of the Faculty concerned, HOD of the department concerned and one member of the Academic council nominated by the principal every year as members.

Distribution of courses and credits are given in the following table.

Semester	Course code	Course	Teaching Hours/ week	Credit	Total Credits
I	20P1ZOOT01	Biosystematics and Animal Diversity	4	4	19
	20P1ZOOT02	Evolutionary Biology and Ethology	4	4	
	20P1ZOOT03	Biophysics, Instrumentation and Biological Techniques	3	3	
	20P1ZOOT04	Biostatistics, Computer Application and Research Methodology	4	4	
	20P1ZOOP01	Practical- 1	10	4	
		Total	25	19	
II	20P2ZOOT05	Ecology- Principles and Practices	3	3	19
	20P2ZOOT06	Genetics and Bio-informatics	4	4	
	20P2ZOOT07	Developmental Biology	4	4	
	20P2ZOOT08	Biochemistry	4	4	
	20P2ZOOP02	Practical -2	10	4	
		Total	25	19	
III	20P3ZOOT09	Animal Physiology	4	4	19
	20P3ZOOT10	Cell and Molecular Biology	4	4	
	20P3ZOOT11	Microbiology and Biotechnology	4	4	
	20P3ZOOT12	Immunology	3	3	
	20P3ZOOP03	Practical- 3	5	2	
	20P3ZOOP04	Practical -4	5	2	
		Total	25	19	
IV	20P4ZOOT13	Environmental Science- Concepts and Approaches	5	5	23
	20P4ZOOT14	Environmental Pollution and Toxicology	5	5	
	20P4ZOOT15	Environmental Management and Development	5	5	
	20P4ZOOP05	Practical -5	5	2	
	20P4ZOOP06	Practical- 6	5	2	
	20P4ZOOPR1	Project		2	
	20P4ZOOVV1	Comprehensive Viva Voce		2	
		Total	25	23	

		Grand Total			**80**
		Extra Credit Courses			
		Internsip (Compulsory)*		2	
		Spider Taxonomy (Optional)		1	
		Ichthyotaxonomy (Optional)		1	

***Internship**

On completion of Semester-II examinations, students will have to undergo a compulsory internship in life-sciences related R&D institutions or industrial units for a period of not less than one month, in April or May. Each student has to submit a report on internship not later than two weeks after completion of the internship. Students should also submit the 'Internship Completion Certificate' obtained from the concerned institution/industrial unit.

SYLLABUS
M.Sc. ZOOLOGY Programme

SEMESTER I

20P1ZOOT01	BIOSYSTEMATICS AND ANIMAL DIVERSITY
20P1ZOOT02	EVOLUTIONARY BIOLOGY AND ETHOLOGY
20P1ZOOT03	BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES
20P1ZOOT04	BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY
20P1ZOOP01	PRACTICAL - 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

20P1ZOOT01 - BIOSYSTEMATICS AND ANIMAL DIVERSITY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To give a thorough understanding in the principles and practice of systematics
- To help students acquire an in-depth knowledge on the diversity and relationships in animal world
- To develop an holistic appreciation on the phylogeny and adaptations in animals

CO	CO Statement	PO/PSOs	CL	KC	Class sessions
CO1	Understand the basic concepts of systematics and taxonomy	PO1, PO4, PO5 PSO3, PSO4	U	C	14
CO2	Understand the procedures in taxonomy and ethics in publications	PO1, PO3, PO4 PSO3, PSO4	U	C	10
CO3	Appreciates the contributions made by scientists and organisations towards conservation of animal diversity	PO3, PSO4	U	C	5
CO4	Understand the present status of Indian fauna and the role played by ZSI for conservation of Indian fauna	PO2, PO3 PSO2, PSO4	U	C	10
CO5	Appreciates the diversity of Palaeofauna	PO1 PSO1, PSO4	U	C	5
CO6	Understands the animal architecture	PO1, PO2, PO5 PSO1,	A	C	3

		PSO2			
CO7	Differentiates the invertebrate fauna by their characteristics	PO1, PO2, PO5 PSO2, PSO4	A	C	15
CO8	Differentiates the vertebrate animals by their characteristics	PO1, PO2, PO5 PSO2, PSO4	U	C	10

BIOSYSTEMATICS **24 hrs**

Module I. Concepts in Biosystematics **8 hrs.**

Systematics and Taxonomy. Levels of Taxonomy - alpha, beta and gamma taxonomy; microtaxonomy – pheneon, taxon, category, macrotaxonomy; Importance of Taxonomy. Three Domain Concept in Systematics, two, five and six kingdom classification. Hierarchy of categories and higher taxa – Linnaean Hierarchy. Concept of species - Typological, Nominalistic, Biological and Evolutionary. Intraspecific Catagories; Variety, Subspeicies, Race, Cline.

Module II. Methods of Biosystematics **3 hrs**

Typological, Phenetics, Evolutionary, Phylogenetic, Taxonomic characters of different kinds.

Module III. Practice of Taxonomy **10 hrs**

Taxonomic Procedures - collection, different types of taxonomic collections, preservation, curetting and identification. Taxonomic Keys as tool of identification, different types of keys, merits and demerits. Use of computer softwares in taxonomic identification.

Process of typification, different zoological types and their significance.

Taxonomic nomenclature - International Code of Zoological Nomenclature (ICZN), Rules and formation of scientific names of different taxa. Importance principles of Zoological Nomenclature - Law of priority, Homonymy and Synonymy. **Taxonomic publications** – description of new taxa, synopses and reviews, taxonomic revisions, monographs, atlases, field guides and manuals, catalogs and checklists.

Ethics in taxonomy - authorship, suppression of data, undesirable practices in taxonomy (brief description only).

Module IV. Modern systematics **3 hrs**

Molecular Taxonomy - use of Proteins, DNA and RNA. Molecular Phylogeny, Phylogenetic trees, Phylocode, Tree of Life. Cladistic analysis and cladograms. Bar-coding of Life – merits and demerits.

ANIMAL DIVERSITY **48 hrs**

Module I. Studies on Indian Fauna – from the past **5 hrs**

Contributions from British period; Organizations - Bombay Natural History Society, The Asiatic Society of Bengal; Publication - *The Fauna of British India, Including*
Ceylon and Burma, Contributors to the research on Indian Fauna (Brief account only) - Patrick Russell, Sir Francis Day, Ferdinand Stoliczka, Jim Corbet, Salim Ali, Sunder Lal Hora, Wynter-Blyth, Romulus Whitaker.

Module II. Indian Fauna-Present status **10 hrs**

An overview of Animal Diversity in India- corals, annelids, commercial crustaceans, butterflies, arachnids, commercial molluscs, commercial fishes, diversity of amphibians, snakes, aves and mammals.
Endangered animals of India, Endemic animals of Kerala.
Western Ghats – Geography, Faunal diversity, endemism
Zoological Survey of India and the role in the conservation of Indian Fauna.

Module III. Diversity of Palaeofauna **5 hrs**

Fossil records of prokaryotes and protists; Edicaran and Burgess Shale fauna. Cambrain explosion- causes and consequences. Fossil record of extinct arthropods, molluscs, echinoderms, fishes, reptiles, birds, and mammals. Animal fossil records from India.

Module IV.Animal architecture **3 hrs**

Animal complexity – acellular/unicellular grade, cellular grade, tissue grade, organ grade and organ system grade. Animal body plans – symmetry and its embryonic origin, body cavities, metamerism, cephalisation, complexity and body size.

Module V. Animal Diversity – Invertebrates **15 hrs**

Diversity of protists with reference to body structure, nutrition, reproduction and life history
Placozoa and Mesozoa
Diversity of protostomes- Porifera, Coelenterata, Ctenophora, Acoelomata, Pseudocoelomata; Phylogeny of Arthropods, Reasons for the success of Arthropods, arthropod larvae; Adaptive Radiation in Molluscs, Larval forms of

Molluscs; Echinoderms - Adaptive radiation, Larval forms of Echinoderms; Hemichordates – Taxonomic position.
Lesser Protostomes (Brief account only) - Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha.

Module VIII. Animal Diversity – Chordates 10 hrs

Diversity of Lower Chordates; Pisces- Chondrichthyes and Osteichthyes; Amphibians, Reptiles, Birds and mammals. Brief account of adaptive radiation of vertebrates.

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20P1ZOOT02 EVOLUTIONARY BIOLOGY AND ETHOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To provide an understanding on the process and theories in evolutionary biology
- To help students develop an interest in the debates and discussion taking place in the field of evolutionary biology
- To equip the learners to critically evaluate the debates and take a stand based on science and reason
- To expose students to the basics and advances in ethology, and generate an interest in the subject in order to understand the complexities of both animal and human behavior

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the concepts of organic evolution	PSO1	U	C	5
CO2	Understand and analyse the evidences of biological evolution	PSO1	U	C	8
CO3	Understand the process of animal evolution through studying the population genetics and ontogeny	PSO1	U	C	16
CO4	Understand the theories regarding human evolution and analyse the molecular evidences of our phylogeny	PSO1	U	C	13

CO5	Understand the significance of studying Ethology	PSO1	U	C	3
CO6	Understand the causal factors of behaviour and different types of behaviour	PSO1	U	C	9
CO7	Understand the Neurophysiological aspects of behaviour	PSO1	U	C	3
CO8	Understand the processes underlying the expression of behaviour patterns by animals	PSO1	U	C	15

EVOLUTIONARY BIOLOGY 42 Hours

Module I. Concepts in Evolution 5 hrs

Concepts of variation, adaptation, struggle, fitness and natural selectionspontaneity of mutation and the evolutionary synthesis. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium), Rose Mary and Peter Grant (Molecular evolution in Darwinian finches).

Module II. Origin and Evolution of Life 8 hrs

The RNA world. Idea of Panspermia. The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, Anaerobic metabolism- origin of photosynthesis and aerobic metabolism.

Module III. Molecular Evolution 3 hrs

Neutral theory of molecular evolution; molecular divergence; molecular drive. Molecular clocks- genetic equidistance.

Module IV. Evidences of Evolution 6 hrs

Evidences from morphology and comparative anatomy - homologous structures, vestigial organs, analogous structures, adaptive radiation, atavism, connecting links.

Evidences from embroyology – egg and developmental stages, similarity of embryos, Baer's law, recapitulation theory.

Physiological and biochemical evidences – protoplasm, chromosomes, DNA, enzymes, hormones, blood groups, excretory products, biochemical recapitulation, comparative serology.

Paleontological evidences – fossils and fossil formation, conditions essential for fossil formation, types of fossils, dating of fossils, significance of fossils, geological time scale.

Module V. Population Genetics 7 hrs

Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect. Isolating mechanisms and speciation. Micro Macro and Mega evolution. Coevolution.

Module VI. Developmental and Evolutionary Genetics 6hrs

The idea of Evo-Devo, Heterochrony, Heterotopy, Heterometry and Heterotypy. Developmental genes and gene co-option. Evolution of plasticity and complexity. Evolution of sex.

Module VII. Primate Evolution and Human Origins 7 hrs Stages in Primate evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin, hominid fossils. Cytogenetic and molecular basis of origin ofmanAfrican origin of modern man- Mitochondrial Eve, Y chromosomal Adam..

ETHOLOGY 30 Hours

Module 1. Introduction and Scope of ethology 3 hrs Historical background and scope of ethology; Terminologies: Sign stimuli, key stimuli, social releasers, displacement activities, ritualization, Ethograms, super normal stimuli, stimulus filtering, IRM, mimetic releaser, code breakers. JP Scotts categories of behaviour. Stimulus-Response, Causal factors, Quantitative aspects - duration, interval, frequency.

Module II. Neurophysiological Aspects of Behaviour 3 hrs Reflex action, Kinesis, Taxes, Fixed action patterns. Sherrington's neurophysiological concepts in behaviour - Latency, summation, fatigue.

Module III. Motivation – Definition 2 hrs

Goal oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives.

Hormones and behaviour, Psycho-hydraulic model of motivation.

Module IV. Learning 3 hrs

Short and long term memory, Habituation, Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting.

Module V. Communication 4 hrs

Evolution of communication, Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees, Pheromonal communication (Ants and mammals).

Module VII. Complex Behaviour 5 hrs

Orientation, Navigation, Migration (Fishes and birds), Navigation cues. Biological rhythms - Circadian, Circannual, Lunar periodicity, Tidal rhythms. Genetics of biological rhythms.

Module VIII. Social Behaviour 5 hrs

Sociobiology (Brief account only)

Aggregations - schooling in fishes, herding in mammals, Group selection, Kin selection, altruism, reciprocal altruism, inclusive fitness, Hamilton's rule, cooperation, territoriality, alarm call, social organization in insects and primates.

Module IX. Stress and Behaviour 2 hrs

Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance.

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Web Resources

http://www.talkorigins.org

http://www.ucmp.berkely.edu

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Web Resources

www.animalbehavioronline.com/modestable.html

20P1ZOOT03 BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

54 Hours (3 hrs/week) **Credit – 3**

Objectives:

- To learn the biophysical properties and functioning of life processes
- To introduce the tools and techniques available for studying biochemical and biophysical nature of life
- To equip the learner to use the tools and techniques for project work/ research in biology

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the biophysical principles that govern the functioning of life processes.	PSO1	U	C	13
CO2	Understand the interactions of electromagnetic radiations with matter.	PSO1	U	C	4
CO3	Understand the techniques for studying live cells and preserved cells under the microscope.	PSO1	U	C	9
CO4	Understand the principles of chromatographic and electrophoretic separation and characterisation of biomolecules.	PSO1	U	C	12

CO5	Understand the technique of centrifugation and its multiple uses in studying cells and biomolecules.	PSO1	U	C	3
CO6	Understand the physics behind radioactivity measurement for medical as well as environmental dosimetry.	PSO1	U	C	2
CO7	Understand the basic principles of bio-nanotechnology and its potential in biomedical applications	PSO1	U	C	3
CO8	Understand the principles of colorimetric, spectroscopic, and biochemical assay techniques for monitoring physico-chemical perturbations of life processes.	PSO1	U	C	8

BIOPHYSICS **17 hrs**

Module I. Diffusion and Osmosis **4 hrs**.

Diffusion -Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants, Facilitated diffusion, Gibbs-Donnan equillibrium.

Osmosis- osmotic concentration and osmotic pressure, Van't Hoff's laws. Biological significance of osmosis in animals and plants.

Module II. Biophysics of Cell Membrane **5 hrs.**

Membrane Transport - endocytosis, exocytosis, Nutrient transport across membranes, porins facilitated diffusion, porter molecules; Facilitated transport:symport,antiport, uniport,anion porter,glucose porter; Active transport: proton pumps, Na^+ K^+ pumps and Ca^{++} pumps, ionic channels. Artificial membranes.

Module III. Bioenergetics **4 hrs.**

Reversible thermodynamics and irreversible thermodynamics; Systems - open, closed and isolated. Redox couple and redox potential. Chemo-bioenergetics: electron transport and oxidative phosphorylation, Chemiosmotic theory and binding change mechanism of ATP synthesis.

Module IV. Radiation Biophysics **4 hrs.**

Interaction of radiation with matter - Photoelectric effect, ion pair production, absorption and scattering of electrons.
Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation : somatic and genetic.

INSTRUMENTATION & BIOLOGICAL TECHNIQUES 37 hrs.

Module I. Microscopy 4 hrs.

Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope - TEM, SEM, Scanning Tunnelling and Atomic Force Microscopes (Brief account).

Module II. Chromatography 6 hrs.

Paper chromatography,Thin layer chromatography, Ion exchange chromatography. Gel permeation chromatography, Affinity chromatography,Gas chromatography High pressure liquid chromatography (HPLC), Brief description of Fast protein liquid chromatography (FPLC).

Module III. Electrophoresis 4 hrs.

Paper electrophoresis,Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) - SDS and non SDS, Disc electrophoresis, High voltage electrophoresis, immunoelectrophoresis, Capillary gel electrophoresis, Electrophoretic mobility shift assay (EMSA).

Module IV. Colorimetry, Spectrophotometry and Spectroscopy 7 hrs.

Principle and applications of colorimetry and spectrophotometry.
Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic- resonance spectroscopy (NMR). Brief account on FourierTransform Infrared Spectroscopy (FTIR), Raman spectroscopy, Circular dichroism spectroscopy, Electron Spin Resonance (ESR) spectroscopy, Mass spectroscopy- Different types and applications: MALDI-TOF, LCMS, Tandem Mass Spectrometry.

Module V. Centrifugation 3 hrs.

Basic principles of sedimentation,Types of centrifuges, Analytical and Preparative centrifugation, Differential and density gradient centrifugation.

Module VI. Radioisotope Detection and Measurement 3 hrs.

Dosimetry: Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography. Nuclear medicine: Internally administered radioisotopes. Radioiodine in thyroid function analysis.

Module VII. Nanotechnology 2 hrs.

Introduction to Nanobiology. Nanosensors and Nanomedicines. Bio-Nanorobotics, Artificial muscles using Electroactive polymers, Multifunctional materials

Module VIII. Assays 2 hrs.

Radio ImmunoAssay, Enzyme Linked Immuno Sorbant Assay (ELISA).

Module IX. pH meter 1 hr.

Principle and working. Types of pH meters.

Module X. Biological and Histological Techniques 5 hrs.

Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching,negative staining.Microphotography.

Cytochemical and histological methods- Microtome techniques, fixation, staining. Cytochemistry of nucleic acids, detection of carbohydrates, proteins and lipids.

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20P1ZOOT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To impart concepts, generate enthusiasm and make awareness about the tools/gadgets and accessories of biological research
- To equip the learner to carry out original research in biology
- To help the students to improve analytical and critical thinking skills through problem solving
- To provide hands on training in the use of various tools and techniques suggested in the course

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand basics of statistics and measures of central tendency and dispersion	PO1, PO5 PSO3	U	C	15
CO2	Understand correlation and regression analysis	PO1, PO5 PSO3	U	C	9
CO3	Understand probability, hypothesis testing and vital statistics	PO1, PO5 PSO3	U	C	12

CO4	Understand the basics of computer application and software	PO1, PO5 PSO3	U	C	10
CO5	Understand the application of SPSS	PO1, PO5 PSO3	U	C	8
CO6	Understand the basic concepts of research	PO1, PO2, PO5 PSO1, PSO2	A	C	5
CO7	Understand research formulation and design	PO1, PO2, PO5 PSO2, PSO4	A	C	7
CO8	Understand information, documentation and communication	PO1, PO2, PO5 PSO2, PSO4	U	C	6
					72

BIOSTATISTICS **36 hrs.**

Module 1. Basics of Biostatistics **5 hrs.**

Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources). Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias.

Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table). Presentation of Data - Types and Characteristics of Tables and Visual aids - Graphs, Charts, Diagrams, Flow charts, Cartographs.(Brief account only)

Statistical Analysis Tools - Parametric and Non-Parametric; Bivariate and Multivariate Analysis. Interpretation and Forecasting.

Module II. Measures of Central Tendency **5 hrs.**

Introduction, Characteristics, Merits and Demerits of Mean, Median and Mode. Calculations/Problems for different data (raw, frequency table). Harmonic and Geometric Mean (Brief account only).

Module III. Measures of Dispersion **5 hrs**.

Introduction, Characteristics, Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation. Calculations/Problems for frequency table.(Brief account only)

Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis (Brief account only).

Module IV. Correlation Analysis **4 hrs.**

Correlation - types and methods of correlation analysis, Problems for Karl Pearson's correlation coefficient and Spearman's rank correlation.

Module V. Regression Analysis **5 hrs.**

Regression and Line of Best Fit , Types and methods of regression analysis. Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of strait line through regression equation).(Brief account)

Probit Analysis (Brief account only), Mathematical Models in Biology (Brief account only).

Length - Weight Relationship.Von- Bertalanffy's Growth (VBG) Model.

Module VI. Theory of Probability **2 hrs.**

Measures of Probability and Theorems in Probability.Probability distributions - Binomial, Poisson and Normal (BriefAccount only).

Module VII. Testing of Hypothesis **6 hrs.**

Hypothesis and types, Confidence Interval, Sampling, Methods and Errors. Tests of significance (For large and small samples - Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test (Problem for 2*2 table only).

Student's 't' test (Problem for small samples comparing mean of two variable). F-test and Analysis of Variance (ANOVA - One way) (Brief account only).

Non-parametric tests: Mc Nemar and Mann Whitney U test (Brief account only).

Module VIII. Vital Statistics **4 hrs.**

Introduction, uses, records and system of classification of vital statistics.

Sample registration system, Sample design, Survey of causes of death and Age classification. Measures of Vital Statistics and Measures of Population (Mortality rates, Fertility rates).

Life tables (Brief account only).

COMPUTER APPLICATIONS **18 hrs.**

Module I. MS OFFICE **10 hrs.**

Introduction to MS Office, Working with Documents -Opening & Saving files, Editing text documents, Inserting, Deleting, Cut, Copy, Paste, Undo, Redo, Find,

Search, Replace, Formatting page & setting Margins, Converting files to different formats, Importing & Exporting documents, Sending files.

Formatting Documents - Setting Font styles, Font selection- style, size, colour etc,
Type face - Bold, Italic, Underline, Case settings, Highlighting, Special symbols, Setting Paragraph style, Alignments, Indents, Line Space, Margins, Bullets & Numbering. Setting Page style - Formatting Page, Pagetab, Margins, Layout settings, Paper tray, Border & Shading, Columns, Header & footer, Setting Footnotes & end notes – Shortcut Keys; Inserting manual page break, Column break and line break.

MS Excel: Spread Sheet & its Applications, Opening Spreadsheet, Menus - main menu, Formula Editing, Formatting, Toolbars, Shortcuts, Spreadsheet types.

Working with Spreadsheets- opening, Saving files, setting Margins, Converting files to different formats (importing, exporting, sending files to others),Spread sheet addressing - Rows, Columns & Cells, Referring Cells &Selecting Cells – Shortcut Keys.

Entering & Deleting Data- Entering data, Cut, Copy, Paste, Undo, Redo, Filling Continuous rows, columns, Highlighting values, Find, Search &replace, Inserting Data, Insert Cells, Column, rows & sheets, Symbols, Data from external files, Frames, Clipart, Pictures, Files etc, Inserting Functions, Manual breaks, Setting Formula - finding total in a column or row, Mathematical operations (Addition, Subtraction, Multiplication, Division, Exponentiation),Using other Formulae. Formatting Spreadsheets.

MS Power Point, Introduction to presentation – Opening new presentation, Different presentation templates, Setting backgrounds, Selecting presentation layouts. Creating a presentation - Setting Presentation style, Adding text to the Presentation. Formatting a Presentation - Adding style, Colour, gradient fills, Arranging objects, Adding Header & Footer, Slide Background, Slide layout. Adding Graphics to the Presentation- Inserting pictures, movies, tables etc into presentation, Drawing Pictures using Draw. Adding Effects to the Presentation- Setting Animation & transition effect. Printing Handouts, Generating Standalone Presentation viewer.

Module II. Statistical Package for the Social Sciences (SPSS) 6 hrs

Basics of SPSS, Data entry in SPSS.
Frequency tables and different types of charts, measures of central tendency, measures of dispersion, distribution of data set.

Parametric tests, ANOVA, t- test.
Non-parametric tests, Wilcoxon test, Mann-Whitney U test, Chi-square test.

Correlation and regression
Simple correlation, partial correlation, simple linear regression, assumptions of regression analysis,

Module III. Primer 6 **2 hrs**
Data entry, analysis of biodiversity indices

RESEARCH METHODOLOGY **18 hrs**
Module I. Basic concepts **1 hrs.**
Scientific temper, Empiricism, Rationalism.

Module II. Concepts of Research **4 hrs.**
Basic concepts of research -Meaning, Objectives, Motivation and Approaches. Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical.
Research methods versus Methodology, Research and scientific method. Research Process.

Module III. Research Formulation **4 hrs.**
Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating the research problem, Selecting the problem and necessity of defining the problem. Literature review -Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review.
Hypothesis -Null and alternate hypothesis and testing of hypothesis

Module IV. Research Designs **3 hrs.**
Research Design -Basic principles, Meaning, Need and features of good design, Important concepts. Types of research designs.
Development of a research plan -Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs. Data collection techniques.

Module V. Scientific Documentation and Communication **3 hrs.**
Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications).
Impact factor, Citation index,H- index
Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

Module VI. Information Science, Extension and Ethics 3 hrs.

Sources of Information -Primary and secondary sources.

Library - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents.

Internet -Search engines and software, Online libraries,digital libraries, e-Books, eEncyclopedia, TED Talk, Institutional Websites.

Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications. Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards.

Extension: Lab to Field, Extension communication, Extension tools.

Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

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20P1ZOOP01 PRACTICAL 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

180 Hours (10hrs./week) **Credit-4**

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Analyse museum specimens, larval forms and to prepare dichotomous keys using software or online tools and to prepare cladogram.	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	60
CO2	Analyse and study the behaviour of two organisms to understand ethology.	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	40
CO3	Application of knowledge of camera Lucida, micrometry, TLC, microscopes and gel electrophoresis	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	30
CO4	Analyse and understand problems of biostatistics	PO1,PO2, PO3,PO4, PO5,	A	P	25

		PSO2, PSO3, PSO4			
CO5	Analyse and understand the basic editing tools in software	PO1,PO2, PO3 PO4, PO5, PSO2, PSO3, PSO4	A	P	25
					180

Biosystematics and Animal Diversity, Evolutionary Biology and Ethology

- Study of museum specimens - 50 invertebrates and 20 vertebrates (List the studied items with brief descriptions.Diagrams not necessary).
- Larval forms - any 10 larvae from different taxa
- Preparation of dichotomous key of 4 specimens up to family (insects/spiders/ fishes/ snakes of any three taxa).
- Development of dichotomous key using appropriate software or online tools
- Preparation of Cladogram based on the specimens provided (at least five museum specimen).
- Construction of phyloggram/cladogram using MESQUITE Software
- Preparation of distribution map using QGIS Software
- Study of fish in response to three temperatures (Normal and + 50C) of water in a microenvironment and preparation of an ethogram.
- Mounting and Submission of any three larval forms (Diversity should be maintained depending on the number of students and one specimen each should be submitted for the practical examination, Repetition should be avoided for examination)
- Study on the skull pattern of reptiles/mammals.

- Behavioural study or activity pattern of any two organism (insects, fish, reptile, birds, mammals) based on field observation with respect to diurnal and seasonal. Viva based on behavioral observation reported. (Repetition of reports, organism and observations should be avoided on records)

Biophysics/Instrumentation/Biological Techniques

- Micrometry- principle and measurement of microscopic objects: Low power and high power.

- Camera Lucida – Diagrammatic representation of specimen using camera lucida

- Principle and working of phase contrast microscope, micro-photographic equipment and pH meter.

- TLC using amino acids from purified samples and biological materials.

- Analysis of biological materials (Arthropodan perilymph) using TLC

- Gel electrophoresis (protein/nucleic acid)

Biostatistics ○ *(Problems can be solved using scientific calculator).*

- Calculation of Pearson correlation coefficient.

- Calculation of regression coefficient and regression equation ('x' on 'y' only)

- Calculation of Chi square value (2x2 table only)

- Calculation of 't' value (for small sample comparing two variable)

- Draw line graph, vertical bar diagram, horizontal bar diagram, histogram, frequency polygon, frequency curve, pie diagram and ogive on graph paper for simple grouped data.

- Calculation of length-weight relationship (use a sample of 25 fishes) - Calculation of 'Z' value

Computer Applications

- MS Excel: Preparation of table

- MS Excel: Preparation of graphs (bar, pie and ogives)
- MS Excel: Formula writing (Addition, Substraction, Multiplication, Division, Power and Root)
- MS Excel: Correlation Analysis
- PH Stat: Basic statistics (mean, median, mode, standard deviation), Chi square test, Students t test, Regression

SEMESTER II

20P2ZOOT05	ECOLOGY: PRINCIPLES AND PRACTICES
20P2ZOOT06	GENETICS AND BIO INFORMATICS
20P2ZOOT07	DEVELOPMENTAL BIOLOGY
20P2ZOOT08	BIOCHEMISTRY
20P2ZOOP02	PRACTICAL - 2: ECOLOGY,GENETICS AND BIO-INFORMATICS, DEVELOPMENTAL BIOLOGY, BIOCHEMISTRY

20P2ZOOT05 ECOLOGY: PRINCIPLES AND PRACTICES

54 Hours (3 hrs/week) **Credit – 3**

Objectives:

- To provide an understanding on the basic theories and principles of ecology
- To help study various disciplines in ecology
- To learn current environmental issues based on ecological principles
- To gain critical understanding on human influence on environment

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the fundamentals of ecology and environment – Physical environment, concept of homeostasis	PO1, PO3, PO4 PSO1, PSO2	U	C	6
CO2	Understand the cybernetic nature of ecosystem - stability through feedback control and through redundancy of components; resistance and resilience stability, Gaia hypothesis.	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO3	Understand structure and function of Ecosystem – Ecological energetics, Animals and nutrient acquisition Biomass and productivity measurement, Biogeochemical cycles	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO4	Understand the concepts of population ecology – Population group properties, growth forms, life history strategies, population structure,	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO5	Understand the concepts of population interactions and the concept of metapopulation	PO1, PO3, PO4 PSO1, PSO2	U	C	7
CO6	Understand the concepts of community - community structure and attributes, ecotone and edge effect. Development and evolution of the	PO1, PO3, PO4 PSO1, PSO2	U	C	3

	ecosystem, guild				
CO7	Differentiate the different kinds of natural resources: Soil, mineral resources, forest resources, aquatic resources, depletion of resources and impacts on quality of life.	PO1, PO3, PO4 PSO1, PSO2	A	C	8
CO8	Differentiate different types energy resources- solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Energy use pattern, recent issues and concepts in energy production and utilization.	PO1, PO3, PO4 PSO1, PSO2	A	C	4
					54

Module I. Ecology and Environment **14 hrs.**
Physical Environment- biotic and abiotic interactions. Concept of Homeostasis;Concepts of habitats- host as habitat, niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement. Cybernetic nature of ecosystem, stability through feedback control and through redundancy of components; resistance and resilience stability.Gaia hypothesis.

Module II. Ecosystem - Structure and Function **10 hrs.** Pathways in ecosystem, energy in the environment-Laws of thermodynamics, energy flow in the ecosystem. Animals and nutrient acquisition – herbivory, carnivory, omnivory, detritus feeding. Primary productivity, Biomass and productivity measurement. Biogeochemical cycles- patterns and types (CNP).

Module III. Population Ecology **15 hrs.**
Population group properties, density and indices of relative abundance,Concept of rate.

Natality and mortality. Population age structure, Growth forms and concept of carrying capacity. Population fluctuations, density dependent and density independent controls.Life history strategies, r & k selection.
Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality - types of territory, territorial defence, floaters, home range.
Population interactions- types, positive and negative, interspecific and intraspecific interactions.Ecological and evolutionary effects of competition.
Concept of metapopulation. Levin's model of metapopulation. Comparison of Metapopulation and Logistic population model. Metapopulation structure.

Module IV. Community Ecology 3 hrs.

Concept of community - community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, concept of climax. Guild and its functioning in the community.

Module V. Resource Ecology 12 hrs.

Natural Resources: Soil-soil formation, physical and chemical properties of soil. significance of soil fertility. Mineral resources with reference to India. Impact of mining on environment; Forest resources- deforestation, forest scenario of India. Aquatic resources - Freshwater and water scarcity, water conservation measures - case studies from India; Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites. Sand mining and its impacts. Wetland reclamation- causes and consequences. Depletion of resources and impacts on quality of life.
Energy Resources- solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development.

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20P2ZOOT06 GENETICS AND BIOINFORMATICS

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To give an in-depth understanding on the principles and mechanisms of inheritance
- To help study the fine structure and molecular aspects of genetic material
- To provide an opportunity to learn the importance of inheritance in Man
- To expose the learners to the emerging field of bioinformatics and equip them to take up bioinformatics studies

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the principles of Genetic Transmission	PSO1	U	C	1
CO2	Understand the Molecular Organization of Chromosomes and Fine structure of Genes	PSO1	U	C	14
CO3	Understand Genetic Linkage, Recombination and Chromosome mapping	PSO1	U	C	9
CO4	Understand DNA replication and Gene Mutation	PSO1	U	C	13

CO5	Understand the concepts of Human Genetics, Extra-chromosomal Inheritance, Epigenetics, Quantitative and Population Genetics	PSO1	U	C	17
CO6	Understand various Bioinformatics databases and their functional areas	PSO1	U	C	6
CO7	Understand the idea of sequence similarity search and sequence analysis methodology	PSO1	U	C	6
CO8	Understand the basic idea of Genomics, Proteomics, systems biology and metabolomics	PSO1	U	C	6

GENETICS **54 hrs.**

Module I.Principles of Genetic Transmission **1 hr.**

Mendelian Principles of Genetics (Brief account only), Gene action-from genotype to phenotype-penetrance and expressivity, gene interaction- pleiotropy, genomic imprinting, phenocopy, *Sex determination,sex linkage, sex limited and sex influenced characters in Man.*

Module II. Molecular Organization of Chromosomes 4 hrs. Genome size and C-value Paradox. Structure of eukaryotic chromosome, nucleosome model. Chromosome condensation - euchromatin and heterochromatin. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve. Unique and repetitive sequences. Mini and micro satellites. Molecular structure of centromere and telomere. Chromosome banding techniques.

Module III. Gene Fine Structure **10 hrs.**

Evolution of the concept of gene function and structure.The definition of gene. The standard genetic code, redundancy and Wobble. DNA Structure- alternate forms of the Double Helix. Gene synthesis (in vitro synthesis) - works of Khorana and Kornberg. Modern findings on the nature of gene: Interrupted genes in eukaryotes, exons and introns-R loops, significance of introns. Genes-within-genes (overlapping genes) Bacteriophage O X174.

Transposable elements in Bacteria -IS elements, composite transposons, Tn3 elements, medical significance. Transposable elements in Eukaryotes-P elements, Retrotransposons, significance of transposons.

Module IV. Genetic Linkage, Recombination & Chromosome Mapping 9 hrs. Chromosome theory of heredity, Linkage and recombination of genes in a

chromosome, crossing over as the physical basis of recombination, Stern's Experiment; molecular mechanisms of recombination (Holliday model), Gene conversion, Recombination mapping with two-point and three -point test cross in Drosophila,Coincidence and Interference.
Genetic mapping by tetrad analysis in Neurospora. Mitoticrecombination. Genetic recombination in Phage, rII locus, complementation test, deletion mapping, conjugation mapping, mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell.

Module V. Gene Mutation **5 hrs.**

Molecular basis of gene mutation; mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Induced mutation, The Ames test for mutagen/carcinogen detection. Inherited Human Diseases with defects in DNA repair, Gene conversion.DNA damage and repair mechanisms

Module VI. DNA Replication **8 hrs.**

The Meselson-Stahl experiment, semi conservative replication of DNA in chromosomes, Unidirectional replication, Bidirectional replication, Theta replication, rolling-circle replication, molecular mechanisms of eukaryotic replication.

Module VII. Human Genetics, Quantitative and Population Genetics 9 hrs.

Karyotype, pedigree analysis, Lod score for linkage testing, genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping. Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, QTL mapping

Module VIII. Applications of Molecular Genetics **4 hrs.**

Identification of human genes and diagnosis of human diseases.Uni parental Disomy, Huntington‟s disease, Fragile X syndrome, Cystic fibrosis. Gene therapySCID-Autosomal disease of immune system, DNA profiling, Micro RNA, Si RNA and their control in Genetic disorders. Mitochondrial gene in Aging and Human Disease.

Module IX. Epigenetics **4 hrs.**

Epigenetics - from phenomenon to field, a brief history of epigenetics - overview and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in **saccharomyces cerevisiae,** position effect variegation, heterochromatin formation and gene silencing in **Drosophila.**

BIOINFORMATICS **18 hrs.**

Module II. Biological Databases **6 hrs.**

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB;

Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt.

Module III.Sequence Analysis **6 hrs.**

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees.

Module IV.Genomics and Proteomics **4 hrs.**

Structural genomics, functional genomics, comparative genomics, data mining in proteomics – Microarrays.

Module V. Systems Biology **2 hrs.**

Introduction, metabolomics, gene network, synthetic biology.

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20P2ZOOT07 DEVELOPMENTAL BIOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To introduce the concepts and process in developmental biology
- To help students understand and appreciate the genetic mechanisms and the unfolding of the same during development
- To expose the learner to the new developments in embryology and its relevance to Man

72 Hours (4 hrs/week) Credit – 4

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand gametogenesis and the process of formation of embryos, and molecular mechanisms that regulate embryo formation	PO1, PO5 PSO1,PSO4	U	C	7
CO2	Understand the process of fertilization and molecular mechanisms working for keeping the identity of species	PO1, PO5 PSO1,PSO4	U	C	8
CO3	Understand the critical nature of axis and structure formation during early embryonic life	PO1, PO5 PSO1, PSO4	U	C	15

CO4	Remember the factors and molecules that have critical roles in normal formation of embryos	PO1, PO5 PSO1, PSO4	U	C	10
CO5	Understand the process of post embryonic development and regeneration	PO1, PO5 PSO1, PSO4	U	C	12
CO6	Understand the different perturbations during embryo formation	PO4, PO5 PSO1, PSO4	U	C	5
CO7	Understand the applied aspects of embryogenesis for treatment of infertility in human beings	PO4, PO5 PSO1, PSO4	U	C	5
CO8	Understand the potential of stem cells and scope of therapeutic cloning	PO4, PO5 PSO1, PSO4	U	C	10

Module I. Early development at molecular level 15 hrs.

Germ plasm and determination of primordial germ cells; germ cell determination – in nematodes, insects, mammals. Germ cell migration in insects, mammals. Primordial germ cells into functional gametes. Molecular biology of gametogenesis. Molecular mechanism of Fertilization – biochemicals involved in maintaining species – specificity, electrical and biochemical mechanisms to ensure monospermy. Biochemistry of egg activation. Control mechanism in cleavage.

Blastulation - significans of mid-blastula transition. Molecular basis of gastrulation.

Module II. Axis and Pattern Formation – vertebrate model 15 hrs.

Significance of axis formation in embryonic patterning – anterior posterior, dorsal ventral, left right axes. Axis formation in amphibian development – Spemann's constriction experiments, transplantation experiments. Embryonic induction, competence – Spemann organizer, Nieuwkoop centre and mesodermal signalling, Molecular basis of mesoderm induction, inducer molecules associated with organizer such as paracrine factors (FGF factors, Hedgehog proteins, Wnt proteins, TGF – β factors, BPM proteins), justacrine factors, transcription factors, role of these molecules in development. Surface receptors and signal transduction pathway - RTK pathway,Smadpathway,Wnt pathway, Hedgehog pathway and cell death pathway. Left-right axis formation.

Module III. Axis and Pattern Formation – invertebrate models 10 hrs.

Early development and axis specification in *Caenorhabditis elegans.*

Early development of *Drosophila*. Molecular mechanism of Anterior-posterior patterning in *Drosophila* - Maternal effect genes, zygotic genes, gap genes, pair rule genes, segment polarity genes; homeotic selector genes, realisator genes. Dorsal-ventral patterning and left right patterning.

Module IV. Postembryonic Development 12 hrs.

Metamorphosis - Morphological changes associated with Amphibian metamorphosis – growth of new structures, cell death and remodelling during metamorphosis. Hormonal regulation of amphibian metamorphosis.

Insect metamorphosis – role of imaginal discs. Hormonal control of insect metamorphosis.

Regeneration – different types; stem cell mediated, epimorphosis, morpholaxis, and compensatory. Mechanism of epimorhic regeneration in Salamander leg, Morphollactic regeneration in Hydra, Compensatory regeneration in mammalian liver. Lens regeneration in amphibia.

Module V. Teratogenesis 5 hrs.

Malformations and disruptions, Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Teratogenic agents – alcohol, retinoic acid, drugs and chemicals, heavy metals, pathogens, environmental oestrogens.

Module VI. Applied aspects of Developmental Biology 5 hrs.

Human Infertility – types and causes (in brief); *In vitro* fertilization and other assisted reproductive technologies (ART). Cloning experiments - (Amphibians, Mammals and Human), ethical issues.

Module VII. Stem cells 10 hrs.

Definition, Pluripotent, multipotent stem cells, embryonic stem cells & adult stem cells, Types of embryonic stem cells - Hematopoietic stem, neural stem cells, cord blood stem cells; Stem cells and therapeutic cloning, Stem cells and regenerative medicine, Transgenic stem cells, Stem cell banks, Ethical issues associated with stem cell experiments.

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CO	CO Statement	POs/PSOs	CL	KC	Class sessions

20P2ZOOT08 BIOCHEMISTRY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To understand the chemical nature of life and life process
- To provide an idea on structure and functioning of biologically important molecules
- To generate an interest in the subject and help students explore the new developments in biochemistry

CO1	Understand structure and classification of different biomolecules – protein, lipid, carbohydrate and nucleic acid.	PO1 PSO1	U	C	24
CO2	Understand the metabolic pathways of different biomolecules	PO1 PSO1	U	C	20
CO3	Understand the disorders of the biomolecules	PO1 PSO1	U	C	10
CO4	Understand the different enzymes and its kinetics	PO1 PSO1	U	C	6
CO5	Understand the biological roles of biomolecules	PO1 PSO1	U	C	4
CO6	Understand synthesis and derivatives of biomolecules	PO1 PSO1	U	C	8

Module I. Carbohydrates **6 hrs.**

Reactions of monosaccharides: Oxidation, reduction, ester formation, osazone formation.

Glycosidic bond.

Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose.

Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Module II. Carbohydrate Metabolism and its disorders **8 hrs**.

Glycogen metabolism- Glycogenesis, Glycogenolysis, Adenylate cascade system, $Ca+^{2}$ Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis

.

Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Galactose metabolism. Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases ,Lactose intolerance, Galactosuria.

Module III. Proteins 10 hrs.

Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pK value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains).

Colour reactions of amino acids and proteins.

Primary structure of protein (e.g. insulin).

Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure- **e.g.** Myoglobin. Quaternary structure **- e.g.** Haemoglobin.

Module IV. Metabolism of Proteins and its disorders 8 hrs.

Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different aminoacids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan, Phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome, sickle cell anemia.

Module V. Lipids 9 hrs.

Classification of lipids: simple, compound and derived lipids. Biological importance of lipids.

Fatty acids: classification, nomenclature.

Simple fats: Triacylglycerol (Triglycerides) - Physical properties. ReactionsHydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes. Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens.

Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroidscholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins. Prostaglandins- structure, types, synthesis and functions.

Module VI Metabolism of Lipids and its disorders 8 hrs.

Alpha oxidation and omega oxidation of fatty acids. **De novo** synthesis of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies - Ketogenesis, Ketolysis, Ketosis.

Module VII. Nucleic Acids **8 hrs.**

Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson - Crick Model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Module VIII. Nucleic Acid and Mineral Metabolism **9 hrs.**

Catabolism of purines and pyrimidines.

Major and minor nutrients. Role of Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride, Sulphur and Iron.

Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Lipid peroxidation. Preventive antioxidants.

Module IX. Enzymes **6 hrs.**

Co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Active site.

Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering.

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20P2ZOOP02 PRACTICAL 2: ECOLOGY,GENETICS AND BIO-INFORMATICS, BIOCHEMISTRY, DEVELOPMENTAL BIOLOGY

180 Hours (10hrs./week) **Credit-4**

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Analyse and study different types ecosystem, food web, food chain, bio geo chemical cycles, qualitative and quantitative estimation of	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3,	A	P	30

	planktons.	PSO4			
CO2	Analyse and study conductivity, ph. ,Applications of instruments, field study report	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	30
CO3	Analyse and study mutants, sexing and culture of Drosophila, phylogenetic tree, gene prediction.	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4			40
CO4	Analyse and study quantitative and qualitative estimations in Biochemistry	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	40
CO5	Analyse and study basic techniques in developmental biology and studies on embryos.	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	40
					180

Ecology

Study of Pond/ wetland/ River ecosystem (any one) - Food web and food chain.
Record the date, time, methodology, and observations in the record book.
Determination of soil organic carbon and chlorides.
Separation and identification of soil arthropods using Berlese funnel.
Qualitative and Quantitative study of marine/freshwater planktons.
Estimation of primary productivity.
Quantitative estimation of salinity, phosphates and nitrates in water samples.
Study of pH and conductivity using pH and conductivity meter (2different samples).
Principles & application of instruments: Rain Guage, Plankton Net, Secchi Disc, GPS. Field Study Report: Three days field study covering River/ Wetland/ Marine

and forests/ grassland. Record ecosystem components (Soil, water, flora, fauna) and interactions. Viva based on Field study.

Genetics and Bioinformatics

Culture, sexing and etherization of Drosophila.
Study of Mutants in Drosophila.
Genetics problems (Di hybrid cross, test cross and sex linked inheritance).
Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, Expasy.
Methods of sequence alignment-BLAST and ClustalW.
Phylogenetic tree using PHYLIP.
Gene Prediction using GENSCAN/GRAI.
Protein structure visualization using RASMOL.

Biochemistry

Quantitative estimation of blood glucose by Folin-Wu/Anthrone /DNS/OToluidine/Enzymatic method
Estimation of proteins by Biuret/ Lowry et al. method
Quantitative estimation of blood urea/ creatine/ uric acid
Quantitative estimation of cholesterol in the blood
Estimation of alkaline and acid phosphatases

Developmental Biology

Study of the developmental stages of Drosophila
Study of the developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill) using permanent slides.
Study of serial sections of embryo (tadpole and chick).
Study of the embryonic development of Zebra Fish
Effect of Lithium chloride on the embryonic development of Zebra Fish
Vital staining of early gastrula of chick - Window method.
Preparation of Shell-less cultures of chick embryos
Chorioallantoic membrane grafting with chick embryo limb buds
Chick embryo – In vitro culture of the limb bud
Blastoderm mounting of chick embryo using vital stains.
Morphological and histological details of different types of mammalian placenta.

SEMESTER III

20P3ZOOT09	ANIMAL PHYSIOLOGY
20P3ZOOT10	CELL AND MOLECULAR BIOLOGY
20P3ZOOT11	MICROBIOLOGY AND BIOTECHNOLOGY
20P3ZOOT12	IMMUNOLOGY
20P3ZOOP03	PRACTICAL - 3: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY
P3ZOOP04	PRACTICAL - 4: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

20P3ZOOT09 ANIMAL PHYSIOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To study and compare the functioning of organ systems across the animal world

- To give an over view of the comparative functioning of different systems in animals
- To learn more about human physiology

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand and compare the functioning of organ systems across the animal world	PSO1	U	F	7
CO2	Understand the mechanism of regulating food intake in human beings as well as problems related with overeating and resultant obesity	PSO1	U	C	10
CO3	Understand the different types of hearts, and functioning of respiratory and circulatory systems of human beings together with their diseases	PSO1	U	C	10
CO4	Understand the osmoregulatory and excretory systems of our body and the factors regulating these processes	PSO1	U	C	12
CO5	Understand the functioning of neurons, nerves and muscles	PSO1	U	C	13
CO6	Understand the sense organs and the transduction processes which convert changes in physical/chemical environment into nerve signals	PSO1	U	C	8
CO7	Understand the mechanism of thermoregulation in human body	PSO3	U	C	4
CO8	Understand the chemical coordination system of animal body and reproductive physiology in relation to endocrinology of mammals	PSO3	U	C	8

Module I. Nutrition **5 hrs.**

Nutrition in animals, mechanisms of food intake in different animals.
Neuronal and hormonal regulation of nutritional intake, hunger drive, thirst.
Obesity- causes and consequence, outline of hormonal involvement. Leptin: synthesis, secretion and its role in adipogenesis.

Module II. Circulation **8 hrs.**

Circulatory mechanisms and fluid compartments, movement of body fluids by somatic muscles, open system, closed system, lymph channels.
Circulatory shock, Circulatory arrest.
Types of hearts – chambered heart, tubular heart, ampullar heart, lymph heart, neurogenic and myogenic heart. Pace makers and specialized conducting fibers. Cardiac cycle, cardiac output, blood pressure, effect of drugs on heart beat, effects of exercise on cardiaovascular physiology. ECG - its principle and significance. Blood buffers, Human congenital heart diseases.

Module III. Respiration **6 hrs.**

Pulmonary ventilation, respiratory muscles, surfactants. Respiratory centers and periodic breathing. Regulation of respiration. Respiration in unusual environment - foetal and neonatal respiration, high altitude, diving. Structure and functioning of respiratory pigments. Metabolic rate : basal metabolic rate and its measurement.

Module IV. Osmoregulation and Excretion **5 hrs.**

Osmoregulation in fresh water, marine and terrestrial animals. Excretion in vertebrates. Physiology and regulation of urine formation. Hormonal regulation of urine formation. Regulation of water balance, electrolyte balance and acid-base balance. Dialysis, artificial kidney, kidney transplantation.

Module V. Nerve Physiology **8 hrs.**

Neuroanatomy of the central and peripheral nervous system. Electrical and chemical transmission. Synaptic transmission. Modifications of synaptic transmission during fatigue, acidosis, alkalosis, hypoxia and drugs. Mechanism of excitatory and inhibitory pathway. Neuromuscular Junction: organization and properties of neuromuscular junction, neuromodulators. Neural control of muscle tone and posture.

Module VI. Sensory and Effector Physiology **8 hrs.**

Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, modality of sensation, secondary sense cells, transduction, relationship between stimulus, intensity and response, sensory coding. Chemical senses: taste, smell, mechanism of reception.
Mechanoreceptors: hair cell, organs of equilibrium, vertebrate ear, mechanism of hearing, electro and thermoreceptors.

Physiology of vision.
Pain: pain receptors, headache and thermal senses, pain suppression (analgesia). Tactile sensation: touch receptors, transmission of signals, special problems of premature infants, Physiological role of touch and environment in premature infants- Kangaroo care, infant massage, supportive environment.

ModuleVII. Muscle Physiology 5 hrs.
Red and white muscles, muscle proteins. Effect of exercise on muscles. Catch muscle and fibrillar muscle.

Module VIII. Thermoregulaion 4 hrs
Comfort zone, body temperature - physical, chemical, neural regulation, acclimatization.
Impact of temperature on the rate of biological functions.
Temperature compensation and temperature regulation in poikilotherms and homiotherms. Adaptations for extreme environments.

Module IX. Endocrinology 15 hrs.
Invertebrate and vertebrate endocrine system. Endocrine glands.
Synthesis, physiologic role, control and mechanisms of hormone action. Neuroendocrine regulation of hormone action.
Bioamines, Ecosanoids, Chalones, Lumones, Phytohormones, Synthetic hormones.

Module X. Reproductive physiology 8 hrs
Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control.
Physiology of implantation, pregnancy, parturition and lactation.
Impact of senescence and age on reproduction.

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20P3ZOOT10 CELL AND MOLECULAR BIOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To help study the structural and functional details of the basic unit of life at the molecular level
- To motivate the learner to refresh and delve into the basics of cell biology
- To introduce the new developments in molecular biology and its implications in human welfare

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the structure of a living cell and its associations at molecular level	PO1, PO2 PSO1, PSO4	U	C	12
CO2	Appreciates the role played by various cell organelles and cytoskeleton	PO1, PO2 PSO1, PSO4	U	C	11
CO3	Understands and differentiates the role played by cell signalling pathways	PO1, PO2 PSO1, PSO4	U	C	15
CO4	Understands the process involved in cell cycle and molecules involved	PO1, PO2 PSO1, PSO4	U	C	7
CO5	Differentiates a cancerous cell from non-cancerous one	PO1, PO2 PSO1, PSO4	U	C	8
CO6	Understands the concept of gene expression	PO1, PO2 PSO1, PSO4	A	C	10
CO7	Appreciates the role played by various molecules at different levels of gene regulation	PO1, PO2 PSO1, PSO4	A	C	9
					72

Module I. Cellular Membranes **4 hrs**

A brief historical overview on the study of cell membrane structure, Fluid mosaic model, Chemistry of cell membrane – membrane lipids, carbohydrates, proteins and the roles they performed, dynamic nature of the plasma membrane, membrane fluidity, lipid raft, brief account on cell membrane functions.

Module II. Cell junctions, Cell adhesion and Extracellular matrix 8 hrs

Chemical nature of Extracellular matrix (Brief account only)

Cellular interactions – with other cells and extracellular matrix; interaction of cells with extracellular matrix: Integrins; Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

Junctions and desmosomes- Tight junctions, Gap junctions and Plasmodesmata.

Module III. Cell Organelles 6 hrs

Endoplasmic reticulum, Golgi complex, Lysosomes, Ribosome, Mitochondria.

Module IV. Cytoskeleton and Cell Motility 5 hrs

Microtubules, Microfilaments, Intermediate filaments

Molecular motors- Non muscle motility and contractility.

Module V. Cell Signaling 15 hrs

Cell surface Receptors: G- Protein coupled receptors (GPCR), Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors

Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG)

Signaling pathways: Cyclic AMP pathway; GPCR pathway in sensory perception; Ras-MAP kinase pathway, Calcium phosphatidyl- inositol pathway

Convergence, divergence and crosstalk among different pathways

Module VI. Cellular Reproduction 7 hrs

Cell cycle: Steps in cell cycle, Control and Checkpoints in mammalian cell cycle. Apoptosis- extrinsic and intrinsic pathways, significance

Module VII. Cancer 8 hrs

Basic properties of a cancer cell; Types of cancer; Causes of cancer; Genetics of cancer- Tumour suppressor gene, Oncogene.

New strategies for combating cancer: Immunotherapy, Gene therapy, Inhibiting cancer promoting proteins,Inhibiting formation of new blood vessels.

Module VIII. Gene Expression 10 hrs

Transcription in prokaryotes and eukaryotes - rRNA, tRNA and mRNA; post transcriptional modifications

Translation in prokaryotes and eukaryotes; post translational modifications

Module IX. Gene Regulation 9 hrs

Gene regulation in prokaryotes - *Lac operon*, *Trp* operon; , Catabolite repression, attenuation.

Gene regulation in eukaryotes at transcriptional, post transcriptional and translational levels; Chromatin-remodelling complexes, Riboswitches, RNA interference (RNAi).

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20P3ZOOT11 MICROBIOLOGY AND BIOTECHNOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To provide an over view of the microbial world, its structure and function
- To familiarize the learner with the applied aspects of microbiology
- To give students an intensive and in-depth learning in the field of biotechnology
- To understand the modern biotechnology practices and approaches with an emphasis in technology application, medical, industrial, environmental and agricultural areas
- To familiarize the students with public policy, biosafety, and intellectual property rights issues related to biotechnology

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the basic concepts of microbiology – Methods, classification, functional anatomy of prokaryotic cells	PO1, PO3, PO4 PSO1, PSO2	U	C	6
CO2	Understand the advanced concepts of microbial metabolism, nutrition, growth, interactions and ecology	PO1, PO3, PO4 PSO1, PSO2	U	C	11
CO3	Understand the advanced concepts of virology	PO1, PO3, PO4 PSO1, PSO2	U	C	3
CO4	Understand the concepts of applied microbiology – Bacteriology of air, water and soil; food microbiology, medical microbiology, bioweapons and bioterrosim	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO5	Understand the basic definitions and scope of biotechnology, intellectual property rights, biosafety and bioethics	PO1, PO3, PO4 PSO1, PSO2	U	C	6
CO6	Differentiate the various tools and techniques in Recombinant DNA Technology	PO1, PO3, PO4 PSO1, PSO2	A	C	12

CO7	Differentiate the various tools and techniques in Animal Biotechnology	PO1, PO3, PO4 PSO1, PSO2	A	C	12
CO8	Understand the advanced concepts of the applications of biotechnology in healthcare, industry, agriculture and environmental biotechnology	PO1, PO3, PO4 PSO1, PSO2	U	C	12
					72

MICROBIOLOGY **30hrs.**

Module I. Introduction to Microbiology **3 hrs.**

Methods of Microbiology, Main group of microorganisms, general characters. Classification, approaches to microbial classification,outline classification, Bergey's manual.

Module II. Functional Anatomy of Prokaryotic Cells **3 hrs.**

Cell structure, plasma membrane, cytoskeleton, cytoplasm, nucleoid, cytoplasmic inclusions.The prokaryotic cell envelope, peptidoglycan structure, gram positive and negative cell walls. Components outside the cell wall: capsules, slime layers and s- layers, pili and fimbriae, flagella and motility. The endomembrane system, mitochondria and chloroplasts, cell wall and pellicle in protists.

Module III. Microbial Metabolism **4 hrs.**

Energy acquisition by chemotrophs and phototrophs, glycolysis (Embden-Meyerhof pathway).

Fermentation, anaerobic oxidations, chemosynthesis. Photosynthesis, carbon assimilation. Regulation of metabolism.

Module IV. Nutrition and Growth **3 hrs.**

Common nutrient requirements, nutritional types, growth factors, uptake of nutrients by the cell.Culturemedia.Reproduction and exponential growth, the growth curve.Physical requirements for bacterial growth and influence of environmental factors on growth.

Module V. Microbial Interactions and Microbial Ecology 4 hrs. Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals.
Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites.

Module VI. Virology 3 hrs.
Properties of viruses**,** structure and chemical composition, genetic composition eclipse, host interaction and specificity**.**Classification, RNA virus , DNA virus, plant virus, animal virus ,bacteriophage, lysis and lysogeny, Viral replication. Virioids and prions.Nature and significance.Pathogenic virus, oncovirus.

MODULE VII. Applied Microbiology 10 hrs.
Bacteria of air, water and soil. Microbes associated with food production and spoilage, microbiology of milk and dairy products.Epidemiology of human diseases, Mechanism of microbial pathogenicity.Normal microbial population on human body, microbial diseases, Nosocomial infections.
Medical mycology. Control of microorganism- physical,chemical and antimicrobial agents.
Biological weapons and bioterrorism.

BIOTECHNOLOGY 42 hrs.

Module 1.Introduction to Biotechnology 2 hrs.
Historical aspects,definitions and scope of Biotechnology.Biotechnology in India.

Module II. Tools and Techniques in Recombinant DNA Technology 12 hrs.
Vectors: cloning and expression vectors - Plasmids, Ti and Ri plasmids, cosmids, phasmids, phagemids, bacteriophage, SV40, vectors with combination features; PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Restriction enzymes and DNA modifying enzymes.
Polymerase chain Reaction- different types and applications. Chromosome walking, chromosome jumping, DNA foot printing. Molecular Markers and ProbesSNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH. DNA sequencing methods- Maxam and Gilberts chemical degradation method, Sanger and Coulson method, Automated DNA sequencers. Site directed mutagenesis, molecular chimeras.
Cloning Methodologies - Gene isolation : Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis. Splicing and integration of isolated gene-cohesive end ligation, homopolymer tailing, extending linkers. Methods of rDNA transfer to host cells- CaCl2 treatment, Virus delivery. Selection and screening of

the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.

Module III. Animal Biotechnology 12 hrs.

Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture. Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, CrossContamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics.

Transfection Methods: CaPO4 precipitation, Shotgun, Electroporation, Lipofection, Microinjection, Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals.

Stem cell culture : General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine.

Module IV. Biotechnology in Healthcare 4 hrs. Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors.RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors-different types, applications - medical and non medical.Introduction to Biochips and their application in modern sciences.

Module V. Biotechnology in Industry and Agriculture 5 hrs.

Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing,downstream processing.

Microbial enzymes and biotranformation- Microbial production of enzymes, fermentation, Enzyme engineering and applications. Food industry- Single cell protein, probiotics. Transgenic plants- Plants with resistance to Pests, plants with increased shelf life.Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology –concept and basics.

Module VI. Environmental Biotechnology 3 hrs.

Sewage treatment. Solid waste management. Biodegradation of xenobiotic compounds. Bioremediation and Biorestoration. Microbial leaching and mining. Biofuels. Transgenics and environment.

Module VII. Intellectual Property Rights, Biosafety and Bioethics 4 hrs.
Introduction to Intellectual PropertyRights, Types of IP: Patents, Trademarks, Copyrights.
Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Introduction to History of GATT, WTO, WIPO and TRIPS.
Biosafety concepts and issues. General guidelines for recombinant DNA research activity. Biosafety protocol 2000.
Bioethics: Principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity *etc.* Ethics in post genomic era-genetic testing and genetic screening.

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20P3ZOOT12 IMMUNOLOGY

54 Hours (3 hrs/week) **Credit – 3**

Objectives:

- To provide an intensive and in-depth knowledge to the students in immunology
- To help the learner to understand the role of immunology in human health and well-being
- To familiarize the students the new developments in immunology

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the overview of immune system	PO1,PO4, PO5 PSO1	U	F	3
CO2	Understand antigens and antibodies and their interactions	PO1,PO4, PO5 PSO1, PSO4	U	C	10
CO3	Understand the complement system	PO1,PO4, PO5 PSO1, PSO4	U	C	5
CO4	Understand the Immune effector mechanisms	PO1,PO4, PO5 PSO1, PSO4	U	C	5
CO5	Understand about allergy and hypersensitivity	PO1,PO4, PO5 PSO1	U	C	4
CO6	Understand about the Major Histocompatibility Complex (MHC)	PO1,PO4, PO5 PSO1, PSO4	U	C	8
CO7	Understand the mechanism of immune reactions behind health problems and diseases	PO1,PO4, PO5 PSO1,PSO4	U	C	15
CO8	Understand the basics of immunological techniques	PO1,PO4, PO5 PSO1, PSO4	U	C	4

Module I. Overview of the Immune System **3 hrs.**

Types of Immunity- Innate and acquired, Passive and active. Pattern recognition receptors- scavenger receptors and Toll – like receptors. Humoral and

cellmediated immune responses. Haematopoiesis. Bcell and T-cell maturation and differentiation.

Module II. Antigens and Antibodies 8 hrs.

Antigen processing and presentation. Monoclonal antibodies and abzymes. Genetic model compatible with Ig structure. Multi- gene organization of Ig genes. Variable region gene arrangements. Generation of antibody diversity. Expression of Ig genes and regulation of Ig genes transcription. Antibody genes and antibody engineering.

Module III. Antigen –Antibody Interactions 2 hrs.

Antigen- Antibody reactions. Biological consequences of antigen-antibody reaction.

Module IV. The Complement System 5 hrs.

Terminal sequence of complement activation (MAC). Classical, Alternate and Lectin Pathways. Complement activation, Regulation of complement system. Biological consequences of complement activation. Complement deficiencies.

Module V. Immune Effector Mechanisms 5 hrs.

Inflammatory Cells. Types of Inflammation- acute and chronic. Chemokines. Role of cytokines in immune system. Properties and functions of Cytokines. Therapeutic uses of cytokines.

Module VI. Hypersensitivity 4 hrs.

Allergy and hypersensitivity. Genetics of allergic response in humans.

Module VII. Major Histocompatibility Complex 8 hrs.

General organization and inheritance of MHC. MHC molecules and genes. Genomic map of H-2 Complex in the mouse. HLA Complex in humans. MHCpeptide interaction. Expression of MHC molecules on different cell types. Regulation of MHC expression. MHC and graft rejection. MHC and disease susceptibility. Biological significance of MHC. HLA typing

Module.VIII. Immunity in Health and Disease 15 hrs.

Immune response during bacterial (tuberculosis),Parasitic (Malaria) and viral (HIV) infections. Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD).Acquired Immunodeficiency Disease (AIDS).Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Animal models for autoimmune disease. Evidences implicating CD4+ T cell, MHC and TCR in autoimmunity.

Induction of autoimmunity. Treatment of autoimmune diseases.

Transplantation immunology. Immunologic basis of graft rejection. Clinical manifestation of graft rejection.
General and specific immunosuppressive therapy. Clinical transplantation. Tumour immunology. Vaccines, Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, Synthetic peptide vaccines, Multivalent subunit vaccines.

Module IX. Immunological Techniques 4hrs.

Serological Reactions. Radio-allergosorbent Test (RAST).Immunoprecipitation. Immunofluorescence. Flow cytometry and fluorescence. Immunoelectron microscopy.

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20P3ZOOP03 PRACTICAL - 3: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY

90 Hours (5hrs./week) **Credit-2**

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Analyse different meiotic stages in Grass hopper testis	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO2	Analyse the salivary gland chromosomes in Drosophila / Chironomus larva.	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO3	Determine the mitotic index in the squash preparation of onion root tip		A		8
CO4	Analyse the effect of drugs on cell division	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO5	Analyse the tissue sample for carbohydrates, Protein , lipids and DNA using histochemical staining	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	24
CO5	Analyse the cell fractions, genomic and plasmid DNA using various techniques	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	6
CO6	Analyse the role of different types of bacteriological media and techniques used	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	18

CO7	Analyse the environmental and food sample for microbial load and faecal contamination	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	10
					90

Cell and Molecular biology and Biotechnology

Squash preparation of grasshopper testis to study meiotic stages.

Squash preparation and identification of salivary gland chromosomes in *Drosophila* / *Chironomus* larva.

Determination of mitotic index in the squash preparation of onion root tip.

Effect of drugs on cell division (Colchicine or any other inhibitor)

Preparation of Microtome section, spreading and histochemical staining of carbohydrates (PAS), Protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain).

Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei

Isolation of genomic DNA and Agarose gel electrophoresis

Isolation of Plasmid DNA.

Microbiology

Sterilization, disinfection and safety in microbiological laboratory

Preparation of culture media

(a) liquid media – nutrient broth , peptone water (b)
Solid media – Nutrient Agar, Mac Conkey' Agar.
(c) Semi solid agar
(d) Firm agar

Culturing of microorganism –
(a) broth culture
(b) culture techniques- streak plate, pour plate culture, lawn culture, stab culture

Isolation and preservation of bacterial culture

Identification of microorganisms-
(a) Staining techniques- Gram staining
(b) Biochemical tests- Oxidase test; Catalase test; Oxidation/fermentation (O/F) test

Antibiotic sensitivity test

Enumeration of microorganisms in the given sample using
(a) haemocytometer
(b) optical density

Environmental sample analysis.
a) Isolation and enumeration of bacteria in water and soil sample
b) Coliform count in water

Identification of symbiotic bacterioids from root nodules of leguminous plant

Bacteriological analysis of milk- methylene blue reductase test

.

20P3ZOOP04 PRACTICAL - 4: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

90 Hours (5hrs./week) **Credit-2**

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Analyse rate of salivary amylase activity on starch; effect of different pH on salivary amylase activity ; influence of temperature on salivary amylase activity – Calculation of Q 10	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	16
CO2	Analyse the effect of drugs on the heartbeat of cockroach & oxygen consumption in fish (normal and stressed).	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	16
CO3	Demonstrate the working principle and applications of kymograph; analyse muscle physiology by virtual Practicals.	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A		12
CO4	Analyse differential count of Human WBC; haematocrit and ESR of Human blood	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	12
CO5	Analyse feeding activity of paramecium	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	6
CO6	Analyse effect of different concentration of NaCl solution on the diameter of RBCs & determination of the concentration	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	12
CO7	Separation of lymphocytes from whole blood; Separation of T and B lymphocytes; Blood Typing in Man.	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3,	A	P	8

		PSO4			
CO8	Demonstrate WIDAL Test, Western Blotting, ELISA & Rocket Immuno-electrophoresis	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
					90

Animal Physiology

Rate of salivary amylase activity on starch (colorimetry)
Effect of different pH on salivary amylase activity (colorimetry)
Influence of temperature on salivary amylase activity – Calculation of Q 10 Effect of drugs on the heartbeat of cockroach (Result with graphical representation corresponding to different concentration and time intervals expected)
Oxygen consumption in fish (normal and stressed).Graphical representation and interpretation.
Kymograph: working principle and applications.
Virtual Practicals in Physiology
(Use of PhysioEX 9.0 : *Laboratory Simulations in Physiology* by P.Zao.,T.Stabler., L.A.Smith and E .Griff. 2011.is suggested) for muscle and nerve physiology practical for class room training and for practical examination in order to replace Frog as per UGC guidelines).
Any four of the following:

(1) Muscle Twitch and the Latent Period
(2) The effect of stimulus Voltage on Skeletal Muscle Contraction
(3) Tetanus
(4) Fatigue
(5) Receptor Potential
(6) The Action Potential Threshold
(7) Importance of Voltage –Gated Na+ Channels

Differential count of Human WBC
Haematocrit and ESR of Human blood
Feeding activity of paramecium

Effect of different concentration of NaCl solution (0.1%-2%) on the diameter of RBCs (preferably human) and determination of the concentration , which is isotonic to the blood from a plot of diameter of RBC against concentration of NaCl

Immunology

Separation of lymphocytes from whole
blood. Separation of T and B lymphocytes
Blood Typing in Man.
WIDAL Test.
Western Blotting –Demonstration
ELISA -Demonstration
Rocket Immuno electrophoresis- Demonstration

Note:

Virtual Practical developed by the Ministry of Human Resources,Govt.of India and available in the web site:**www.vlab.ac.in** can be availed for demonstration.

SEMESTER IV

20P4ZOOT13	ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES
20P4ZOOT14	ENVIRONMENTAL POLLUTION AND TOXICOLOGY
20P4ZOOT15	ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT
20P4ZOOP05	ENVIRONMENTAL SCIENCE PRACTICAL - 1
20P4ZOOP06	ENVIRONMENTAL SCIENCE PRACTICAL - 2

20P4ZOOT13 ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES

90 Hours (5 hrs/week) **Credit – 5**

Objectives:

- To provide a broad and deep understanding on environment and influence of man on environment
- To equip the students to use various tools and techniques for the study of environment
- To enable the learner to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth
- To take up further studies and research in the field

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the concepts of physical environment – Lithosphere, atmosphere and hydrosphere	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Understand the fundamental and advanced concepts of weather and climate	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO3	Understand the climate of India	PO1, PO3, PO4 PSO1, PSO2	U	C	4
CO4	Understand the concepts of Landscape ecology	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO5	Understand the concepts of Biodiversity and Conservation	PO1, PO3, PO4 PSO1, PSO2	U	C	24

CO6	Understands the major environmental/conservation laws and rules and biogeography of India	PO1, PO3, PO4 PSO1, PSO2	U	C	12
CO7	Understand the concepts of biological invasions	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO8	Understand the concepts of environmental economics	PO1, PO3, PO4 PSO1, PSO2	A	C	4
					90

Module I. The Physical Environment 18 hrs.

Lithosphere - Weathering and soil formation, - soil colloids, adsorption and exchange of anions and cations, role of microbes in soil, types of soil, soil profile, classification of rocks, folds, faults and dykes and other geological formations and their environmental significance. Geomorphological processes-plate tectonics, sea floor spreading, mountain building, evolution of continents and structural deformation.

Atmosphere -Physico-chemical characteristics, divisions, composition and significance of atmospheric components.

Hydrosphere -Visible and invisible hydrosphere, Range of aquatic habitats, water cycles between earth and the atmosphere, Global water balance, ice sheets, origin and composition of sea water, sea level changes, River basins and watershed. Physico-chemical characteristics of water- diffusion of oxygen from the atmosphere to surface waters. Influence of pH, turbidity and light on aquatic life.

Module II. Weather and Climate 10 hrs

Definitions and scope of climatology, weather and climate, components of climate system, earth's thermal environment, earth intercepts solar radiation, seasonal variation in intercepted solar radiation, air temperature in relation to altitude, global circulation of air masses, wind and earth's rotation on ocean currents, influence of temperature on moisture content of air, global pattern of precipitation , influence of topography on regional pattern of precipitation. classification ofclimate-Koeppen's classification and Thornthwaite's scheme, climatic types and zones.

Global climatic phenomena-El Nino and La Nina, causes and factors of climate change. Effect of climate change on ecosystems and human welfare. Organisms and microclimate.
International Agreements on Climate Change – UNFCC - 1992, Kyoto Protocol - 1997, Copenhagen accord, Paris agreement - 2015

Module III. Climate of India 4 hrs

Climatic regions of India, tropical monsoon climate-onset, rain bearing systems, break in the monsoon, retreat of monsoon. Monsoon in Kerala, oceanic and continental influence.

Module IV. Landscape Ecology 8 hrs

Land and Landscape processes; Hierarchy: ecosystems to land units; Concept of ecological land degradation, desertification, water logging, salinisation and soil erosion. Ecological assessment of landscape for vegetation and habitats. Integrated analytical techniques- land suitability analysis and carrying capacity studies; Use of soil survey, aerial photos, topographic maps and other resource data in landscape management.

Module V. Biodiversity and Conservation 24 hrs

Types of biodiversity-wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services. Drivers of biodiversity loss.
Tools and techniques for biodiversity estimation- biodiversity indices.
Strategies for biodiversity conservation- In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; Invitro Conservation: germplasm and gene bank; tissue culture: pollen and spore bank, DNA bank. GEF-World Bank initiatives.
Biodiversity hotspots and their characteristics, global distribution.
National and international programmes and agencies for biodiversity conservation and environmental management: UN Conventions and Protocols, CBD, IUCN, WCMC, WRI, WWF, CI, CITES, TRAFFIC, Green Peace. National and Local NGOs. UNFCC and IPCC.
National Board of Biodiversity, State Board of Biodiversity.
Ecosystem people and traditional conservation strategies; People's participation in conservation-PFM, Community reserves, Sacred groves, Biovillages, People's Biodiversity Register (PBR). Biodiversity Management Committee (BMC). Wildlife values and eco-tourism, wildlife distribution in India. Threatened animals of India.
Restoration Ecology- need and policies, case studies and success stories - global and national;

Module VI. Major environmental/conservation laws and rules in India 6 hrs
Wildlife Protection Act 1972 amended 1991, Forest Conservation Act, 1980, Air (Prevention and Control of Pollution) Act 1981, Water (Prevention and Control of Pollution) Act 1974, amended 1988, The Environment Protection Act, 1986 and Rules, 1991. The Biological Diversity Act 2002, Rules 2004. Coastal Regulation Zone (CRZ) Notification 1991 & 2011 – Classification of Costal Zones and regulation of developmental activities.

Module VII. Biogeography 6 hrs.
Major terrestrial Biomes, theory of island biogeography, bio-geographical zones of India; Western Ghats and its significance.

Module VIII. Biological Invasions 10 hrs
Elton's hypothesis. Biological attributes for invasion: Reproductive potential, Allelopathy Phenotypic plasticity, fitness to the new environment. Hypotheses for invasion success: Natural enemy hypothesis evolution of invasiveness hypothesis, empty niche hypothesis, novel weapon hypothesis, disturbance hypothesis and Propagule pressure hypothesis. Invasive alien species of India (plants and animals). Databases of biological invasions. Impacts and management of invasions: impacts of exotics on biodiversity, productivity, nutrient cycling. Management: Bio-control programmes, mechanical and chemical control.

Module IX. Environmental Economics 4 hrs
Origin and scope of environmental economics, Green Economy: sustainable utilisation of natural resources.

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20P4ZOOT14 ENVIRONMENTAL POLLUTION AND TOXICOLOGY

90 Hours (5 hrs/week) **Credit – 5**

Objectives:

- To provide a broad and deep understanding on environment and influence of man on environment
- To equip the students to use various tools and techniques for the study of environment
- To enable the learner to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth
- To take up further studies and research in the field

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the concepts of pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Understand air and water pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	27
CO3	Understand the sources and the factors affected by soil pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	25
CO4	Understand the management of solid waste, the various rules in place regarding hazardous waste, biomedical and plastic waste	PO1, PO3, PO4 PSO1, PSO2	U	C	7
CO5	Understand the concepts of noise, thermal and oil pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO6	Understand the concepts of Radiation pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	8

CO7	Understand the definition, doses and toxic chemicals in the environment	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO8	Understand occupational toxicology, toxicity testing and biomonitoring of toxic chemicals	PO1, PO3, PO4 PSO1, PSO2	A	C	10
					90

Module I. Introduction **3 hrs.**

Brief history of human civilization, industrialization and urbanization. Definition of pollution. Different types of pollution- Air, Water and soil and their local, regional and global aspects.

Module II. Air Pollution **12 hrs.**

Sources and classification of air pollution ; particulates and gaseous pollutants in the atmosphere.

Primary and secondary pollutants. Effects of air pollutants on human health, animals, vegetation, materials and structures.

Air pollution monitoring - methods, air quality standards; ISI, EPA.

Sampling and measurement of particulate matters (SPM) - gaseous pollutants, CO_2, CO, NOx, SO_2,H_2S, oxidants, ozone and hydrogen fluoride.

Control of gaseous emission: adsorption by liquids, adsorption by solids, combustion and condensation.

Control of SO_2, NOx, CO, CO_2 and hydrocarbons. Carbon sequestration, carbon credit, carbon footprint and carbon trade.

Any one case study (Delhi air pollution)

Module III. Water Pollution **15 hrs.**

Sources of water pollution-Domestic (municipal sewage), industrial and agricultural. Health effects of water pollution. Water borne and water related diseases. Effects of water pollution on aquatic system.

Water quality standard for potability - Pollution parameters, BOD, COD, Coliform bacteria.

Treatment of water for potable purpose (mixing, sedimentation, coagulation, filtration and disinfection)

Primary and secondary treatment. Sludge disposal. Biological treatment: Kinetics of Biological growth - activated sludge treatment - trickling filters - anaerobic digestion, combined aerobic and anaerobic treatment process, aerobic process.

Advanced waste water treatment - removal of dissolved organics and inorganic - precipitation, iron exchange, reverse osmosis, electro dialysis, adsorption and oxidation.
Removal of nutrients. Removal of heavy metals - overall waste water treatment for sewage water.
Water pollution treatment using constructed wetlands Bioremediation; traditional water purification techniques.
Any one case study (National Mission for Clean Ganga)

Module IV. Soil Pollution 10 hrs.
Sources of soil pollution; - agricultural, industrial and domestic. Hazardous waste compounds, formulations and classes of substances, chemical classification of hazardous waste.
Soil factors affected by pollution – physico-chemical and biological impacts. Case studies on soil pollution in wetland and Highland soils in Kerala. Control of soil pollution. Soil quality parameters and test methods.

Module V. Solid Waste Management 15 hrs.
Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems- composting, vermicomposting; Biodigesters (Biogas plants); incineration, pyrolysis, plasma pyrolysis; sanitary landfills and open dumping yards. Management of plastic and e-waste. Better management strategies (any two model case studies). Treatment process for unsegregated waste, fixation of hazardous solid waste prior to disposal, hazardous waste in land fill.
Hazardous waste (Management and Handling) Rules 1989 - the Manufacture Storage and Import of Hazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998 - Plastic Act 1999. Extended producer responsibility.

Module V. Noise, Thermal and Oil Pollution 7 hrs.
Properties of sound and noise. Effects of noise on People and ecosystem. Basic principles of noise control. National and International Standards. Assessment and measurement of sound.
Thermal Pollution-causes and consequences
Oil pollution – causes and consequences (any two case studies).

Module VI. Radiation Pollution 8 hrs.
Radiation pollution- Definition, Radioactivity, Radionuclide, Radiation emissions, sources, Radioactive decay and buildup. Biological effects of radiation.

Radioactive pollution impacts on ecosystem. Nuclear reactor disasters (Any two case studies), safety standards.

Module VII. Toxicology 20 hrs.

Definition, scope and history of toxicology, Acute and chronic toxicity, selective toxicity, dose, synergism and antagonism.

Dose – Response relationships – Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC50; Margin of safety; Toxicity curves; Cumulative toxicity and LD50 and CTF.

Toxic chemicals in the Environment – Biochemical aspects of As, Cd, Pb, Hg, Cu, O3, PAN, pesticides, MIC and other carcinogens. Bio accumulation and biomagnification.

Occupational toxicology- hazardous chemicals, disorders from chemical exposure at work, assessment of occupational hazards.

Toxicity testing; Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC50, Limitation and importance of bioassay, acute toxicity (single); sub acute toxicity; chronic toxicity; teratogenicity, carcinogenicity and mutagenicity.

Bio-monitoring of toxic chemicals - objectives, programs and parameters, concepts of bio indicators.

Bio-transformation of Xenobiotics (Selective Toxicity).

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20P4ZOOT15 ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT

90 Hours (5 hrs/week) **Credit – 5**

Objectives:

- To provide a broad and deep understanding on environment and influence of man on environment
- To equip the students to use various tools and techniques for the study of environment
- To enable the learner to understand, think and evolve strategies for management and conservation of environment for sustaining life on earth
- To take up further studies and research in the field

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the principles of environmental management, modelling and auditing	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Understand the fundamental and advanced concepts of environmental management concepts	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO3	Understand environmental planning, ecoremediation and restoration	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO4	Understand the concepts and objectives of EIA and its processes like Baseline data collection, Impact assessment, Impact prediction, EMP	PO1, PO3, PO4 PSO1, PSO2	U	C	10

CO5	Understand the concepts EIA documentation, types of impact assessment, SEA, CIA, SIA	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO6	Understand the concepts and principles of remote sensing and GIS and their applications to environmental studies	PO1, PO3, PO4 PSO1, PSO2	U	C	15
CO7	Understand Environment and Development, land use pattern, participatory environmental management strategies	PO1, PO3, PO4 PSO1, PSO2	U	C	5
CO8	Understand the concepts of sustainable development	PO1, PO3, PO4 PSO1, PSO2	U	C	12
					90

Module I. Environmental Management **18 hrs.**

Basic principles of environmental management.

Environmental modeling; Brief on simulation modeling; Softwares and resource management.

Tool box for environmental management- Ecological foot print, carbon footprint, Water foot print, Happy Planet Index (HPI)

Environmental auditing; Eco labeling and certification, accreditation; Corporate social responsibility and Corporate environmental responsibility; ISO standards for environmental management systems (EMS) ISO 14000 family of standard, ISO 26001; OHSAS 18001.

Module II Ecosystem Management **20 hrs.** An overview Population, Resources and ecosystem management, Exponential growth in human numbers and the implications.

Major management concepts and methodologies The five basic laws of Ecology and their relevance for ecosystems management; paradigm shifts in the management of Ecosystems- influence of economics in ecology.

Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas.

Environmental planning and management of – waste lands, reclaimed lands, mining areas, human settlements, industrial lands and agricultural lands.
Ecorestoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management.

Module III. Environmental Impact Assessment (EIA) 20 hrs.
Introduction - Definition, objectives, history of EIA, Historical, legal and regulatory aspects of EIA in India, **EIA process** – **a)**. Baseline data collection (Environmental Inventory, Environmental Baseline Monitoring - EBM) **b).** Screening, **c).** Scoping – Terms of Reference (TOR), Identification of Valued Environmental Components (VEC), **d).** Impact assessment – various methods: Adhoc method, Checklist method, Matrices, Network method, Map overlays method, **e).** Impact prediction – Mathematical modelling, computer modelling, **f).** Environmental Management Plan
(EMP) - preparation, implementation and review, Mitigation and Rehabilitation; **g).** Documentation of EIA findings – Environmental Impact Statement (EIS); **h).** Decision making; **i).** Public Participation in EIA; Environmental Clearance (EC) Process in India; Types of Impact Assessment (Brief account only) - Risk assessment (RA) and disaster management programme, Life Cycle Assessment (LCA) and its significance, Strategic Environmental Assessment (SEA), Cumulative Impact Assessment (CIA), Social Impact Assessment (SIA), Health Impact Assessment (HIA).

Module IV. Remote Sensing and GIS 15 hrs.
Principles and concepts of Remote Sensing: Electromagnetic spectrum; spectral characteristics of surface features (rocks, soils, vegetations, water). Space Imaging Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT. Satellites and their sensors, geometry and radiometry,
Digital Image Processing: Principles, Image Rectification and restoration, Image enhancement and Mosaicing. Image classification. Supervised, Unsupervised, Ground truth data and training set manipulation, Classification accuracy assessment. Geographical Information System (GIS): Basic principles and terminologies, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography; Software used in GIS Surveying: Leveling, Triangulation, Geodetic survey; Global Positioning System (GPS) Basic principles, Applications to environmental studies.

Module V. Environment Vs Development 5 hrs.
Conflicts of interest - environment and development, Industrial revolution and environmental consequences, Modern agriculture and green Revolution - environmental impacts, Changes in land use pattern and its environmental

impacts, Tragedy of the commons, Participatory environmental management strategies.

Module VI. Sustainable Development 12 hrs. Definition and concept - History and emergence of the concept – Our Common Future - Objectives of Sustainable Development - Imperatives relating to sustainable development – International summits on sustainable development – UNCED and Agenda 21, Rio Declaration (27 principles) - Johannesburg Conference 2002 (WSSD - "Rio+10") – UNCSD (Rio+20) - Commission on Sustainable Development (CSD) - Sustainable Development Goals (SDGs) - 2030 Agenda for Sustainable Development - Sustainability indicators and Assessment mechanism – Constraints and barriers for Sustainable Development – Gandhian environmentalism.

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UN General Assembly.2010. *Keeping the promise: a forward-looking review to promote an agreed action agenda to achieve the Millennium Development Goals by 2015.* Report of the Secretary General.

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Web Resources

www.moef.gov.in (of Ministry of Environment and Forests, Govt. of India) www.millenniumassesment.org. (for Millennium Ecosystem Assessment Synthesis Reports) www.unep.org

http://www.un.org/sustainabledevelopment

20P4ZOOP05 ENVIRONMENTAL SCIENCE PRACTICAL - 1

90 Hours (5hrs./week) **Credit-2**

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Understand the concepts of physical environment – Lithosphere, atmosphere and hydrosphere	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Understand the fundamental and advanced concepts of weather and climate	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO3	Understand the climate of India	PO1, PO3, PO4 PSO1, PSO2	U	C	4
CO4	Understand the concepts of Landscape ecology	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO5	Understand the concepts of Biodiversity and Conservation	PO1, PO3, PO4 PSO1, PSO2	U	C	24
CO6	Understands the major environmental/conservation laws and rules and biogeography of India	PO1, PO3, PO4 PSO1, PSO2	U	C	12

CO7	Understand the concepts of biological invasions	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO8	Understand the concepts of environmental economics	PO1, PO3, PO4 PSO1, PSO2	A	C	4
					90

Soil texture using micrometry from two different sites.

Determination of moisture content.

Determination of soil pH from at least three different locations and correlate it with the soil type
.
Determination of Chloride, Calcium, Magnesium, Potassium and Phosphorous.

Determination of Calcium Carbonate in Egg shell- (Three different types of egg; calculate the mean value and the standard deviation, and compare it with the standard values).

Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results- compare the results of Dark and Light bottle method and Chlorophyll method.

Identification of trophic levels from gut analysis (Fish or insect)

Computation of diversity indices using Primer software.

20P4ZOOP06 ENVIRONMENTAL SCIENCE PRACTICAL - 2

90 Hours (5hrs./week) **Credit-2**

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Analyse air quality	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO2	Analyse pollutants in ambient and polluted air	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO3	Determine pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica in water	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	20
CO4	Determine total dissolved salts (TDS) in water	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	4

CO5	Analyse water for toxicity	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO6	Determine LC50	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	4
CO7	Differentiate histopathological changes in animal tissues	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
CO8	Perform field study	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	30
					90

Air Quality Analysis:
Air samplers - Simple, Handy and High volume air samplers.
Monitoring of the following pollutants in ambient and polluted air: 1. Dust fall 2. Suspended particulate matter 3. Sulphation rate using lead peroxide candle. 4. Sulphur dioxide 5. Nitrogen dioxide 6. Ammonia

Water Quality Analysis:
a. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica
b. Determination of total dissolved salts (TDS)

Toxicity Analysis of Water: For Chlorine, H_2S, Ammonia, Copper and Chromium
Estimation of BOD and COD of polluted water

Determination of LC50 for fish (pesticide) using Probit analysis (use of appropriate software is suggested to find out the value)

Study of histo-pathological changes in any two of the tissues (Liver/ Kidney/ Gonad) using CCl4 or NH3 (five stained permanent slides [normal and affected] to be submitted for the examination).

Field Study Report: (Three /four days)
Visit to Institutions engaged in environment /conservation research; a sanctuary/national park and an industrial /polluted area. Report the study conducted and submit a 10 page write up/ print out giving the dates, daywise itinerary, methodology, results and references. Include photgraphs of the activity. Group and individual assignments shall be preferred. (*The activity suggested in Practical -1 can be clubbed with this field study).*

SYLLABUS
Extra-Credit Courses

Spider Taxonomy

18 hrs **Credit: 1**

Objectives

1. To understand the basics of Taxonomoy concepts
2. To get acquainted with the morphology, anatomy, biology and ecology of spiders.
3. To acquire the basic skills of spider identification

Module 1: General perspectives **2 Hrs**

Definition and objectives of taxonomy; Levels of taxonomy – alpha, beta and gamma; Significance of taxonomy; Typess- Holotype, Lectotype, Paratype, Neotype, Syntype; Taxonomic keys; ICZN

Module II: Morphology & Natural History of spiders **4 Hrs**

Morphology: Prosoma, Opisthosoma, Spinnerets, Genitalia; Feeding - Prey capture – Mygalomorphae and Araneomorphae, Cannibalism; Courtship and mating; Egg and egg sacs; Hatching and moulting; Parental care; Dispersal mechanisms

Module III: Collection and Preservation of spiders **2 Hrs**

Collection methods- Visual search and handpicking, Sweep net, Beating, Fogging, Berlese funnel extraction, pitfall trap; Preservation in field and laboratory; Storage and Curation; Cataloguing of specimens

Module IV: Taxonomy of spiders **10 Hrs**

Systematic position; Mesothelae, Mygalomorphae, Araneomorphae; Haplogyne and Entelegyne; Cribellate and Ecribellate spiders

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Ichthyotaxonomy

18 hrs **Credit: 1**

Objectives

- To understand the basic concepts of fish taxonomy
- To get acquainted with the morphology, anatomy, biology and ecology of fishes.
- To acquire the basic skills of fish identification

Module 1: General perspectives **1 Hr**

Prospects of fish taxonomy, General idea on fishes and Significance of taxonomic studies

Module II: Morphology, Anatomy and Ecology **3 Hrs**

Morphology and Anatomy of fin fishes- Chondrichthys and Osteichthys- Sharks and Rays of Indian region. Body form, colouration, fins and scales, habitat specificity of freshwater fishes of Indian region

Module III: Taxonomy **14 Hrs**

Taxonomic characteristics of finfishes- Body form, Scales, Number and type of fins, finrays and spines, finray counts. Ethological characteristics. Web resources for fish taxonomy 2 Hours

Morphometrics- Measures and Counts of taxonomic characters including osteological features- spines and protrusions of the skull, Gill rakers, Barbels. Osteological studies- Methodology of bone and cartilage staining. Examples and Demonstrations of morphometric data collection 6 Hours

Important Freshwater and Brackish water fishes of Kerala-Taxonomic features, Orders of freshwater and brackish water fishes reported from India 4 Hours

Molecular phylogenetics- Important molecular markers, mitochondrial DNA sequences and methodology of DNA extraction and selection of DNA Markers, Construction of Phylogenetic trees, Statistical analysis . 2 hours

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