SACRED HEART COLLEGE
Autonomous

CURRICULUM AND SYLLABI

CREDIT SEMESTER SYSTEM (CSS)

M.Sc. ZOOLOGY PROGRAMME

INTRODUCED FROM 2021 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 25/07/2019, Thursday at 3 pm in the department discussed and approved the final revised syllabus for the M. Sc. Zoology Programme wef 2021- 2022 admissions.

CONTENTS

Introduction, outcomes and eligibility for admission

Zoology is central to our understanding of the natural world, it seeks to discover the fundamental principles that underpin animal life focusing on their diversity, function and evolution of animals and thus providing the scientific basis for our knowledge both of the creatures with whom we share this planet and of ourselves. It is a vibrant and growing discipline with substantial relevance for modern society. Knowledge of animal's biology contributes to the development strategies to deal with environmental changes, strive for renewable sources, reduce and cope with pollution, discover new biologically based solutions to human/animal diseases and develop biopharmaceuticals. Undeniably, the study of Zoology is increasingly recognized as vital for understanding and protecting our planet. This subject has a significant role in human resource development, food security, environmental conservation, sustainable development and alleviation of poverty.

The creation of a scientific thinking and scientific attitude necessitates proper education and guidance. In order to achieve this, one must update the developments in every field of science. An effective science education can be imparted at the postgraduate level only by constantly updating the existing curriculum. The present postgraduate curriculum in Zoology was revised in 2016 after the college was elevated to 'Autonomous' status in 2014. The Board of Studies in Zoology then revised the curriculum in tune with the parent University and the University Grants Commission's model for Postgraduate Curriculum. In this process, care has been taken to give emphasis to various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, the skills essential for handling equipment and instruments in laboratories and industries, developing research aptitude, employability and entrepreneur development. Care has also been taken to introduce into the curriculum, student centric learning methods such as experiential learning, participative learning and problem-solving methodologies.

The meeting of the Board of Studies in Zoology was held on 25th July 2019 and the BoS recommended the revision of the existing PG Zoology Syllabus in comparison with the parent university (MG University) syllabus with appropriate modifications. The Academic Council of the college decided to implement the revised syllabus with effect from the academic year 2021-22.

Programme Outcomes

At the end of the programme, the students will

PO1: Exercise their critical thinking in creating new knowledge leading to innovation, entrepreneurship and employability.

PO2: Effectively communicate the knowledge of their study and research in their respective disciplines to their stakeholders and to the society at large.

PO3: Make choices based on the values upheld by the institution, and have the readiness and know-how to preserve the environment and work towards sustainable growth and development.

PO4: Develop an ethical view of life and have a broader (global) perspective transcending the provincial outlook.

PO5: Explore new knowledge independently for the development of the nation and the world and are able to engage in a lifelong learning process.

Programme Specific Outcomes

At the end of the programme, the students will

PSO1: Demonstrate 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, relate physiological adaptations, development, reproduction, behaviour and evolution of different forms of life.

PSO2: Interpret 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.

PSO3: Experiment with techniques and methods of analysis appropriate for different branches of biology with scientific temperament and problem-solving attitude.

PSO4: Acquire techniques and skills in the design and execution of 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

Eligibility for Admissions: B Sc. Zoology with 50% marks.

Medium of Instruction and Assessment: English.

Faculty under which the Degree is Awarded: Science

Specialization offered: Environmental Sciences.

Note on compliance with the UGC Minimum Standards for the conduct and award of Postgraduate Degrees: Two years having four semesters.

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2021

2.1 TITLE

These regulations shall be called 'SACRED HEART COLLEGE REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2021

2.2 SCOPE

Applicable to all Post Graduate (PG) programmes of the college with effect from 2021-22 admissions. The provisions herein supersede all the existing regulations for the post graduate programmes of the college.

2.3 DEFINITIONS

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

2.3.2 **'Duration of Programme'** means the period of time required for the conduct of the programme. The duration of post graduate programme shall be of four semesters spread over two academic years.

2.3.3 **'Semester'** means a term consisting of a minimum of ninety working days, inclusive of examination, distributed over a minimum of eighteen weeks each having five working days, each with five contact hours of one hour duration.

2.3.4 **'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 requirements.

2.3.5 **'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.

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

2.3.7 '**Programme Credit'** means the total credits of the PG Programmes. For PG programmes the total credits shall be eighty.

2.3.8 **'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.

2.3.9 **'Elective Group'** means a group consisting of elective courses for the programme.

2.3.10 '**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.

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

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

2.3.13 '**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.

2.3.14 'Evaluation' is the process by which the knowledge acquired by the students is quantified as per the criteria detailed in the regulations.

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

2.3.16 'Audit Course' is a course for which no credits are awarded.

2.3.17 'Department' means any teaching department offering a programme of study approved by the college / institute as per the Act or Statute of the University.

2.3.18 'Department Council' means the body of all teachers of a department in a college.

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

2.3.20 'College Coordinator' means a teacher from the college nominated by the College Council to look into the matters relating to the CSS-PG system.

2.3.21 'Letter Grade' or simply **'Grade'** in a course is a letter symbol (A^+, A, B^+, B etc.) which indicates the broad level of performance of a student in a course.

2.3.22 'Grade Point' (GP), is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

2.3.23 'Grade Point Average' (GPA) is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade points obtained in the course by the sum of the weights of the course ($GPA = \sum WGP/\sum W$).

2.3.24 'Weighted Grade Point' (WGP) is obtained by multiplying the grade point by its weight (WGP = GP x weight).

2.3.25 'Credit Point' (CP) of a course is the value obtained by multiplying the grade point (GPA) by the credit (Cr) of the course (CP = GPA x Cr).

2.3.26 '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 of the courses taken by him/her in that semester. The SGPA

shall be rounded off to two decimal places and it determines the overall performance of a student at the end of a semester.

2.3.27 '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.

2.3.28 '**Grace Grade Points'** means grade points awarded to a student for course(s), in recognition of meritorious achievements in NSS/Sports/Arts and cultural activities, as per the orders issued by the college from time to time.

2.4 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.

2.4.1 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.

2.4.2 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 similar cases.

2.4.3 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.

2.4.4 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 the Head of the Department, and submit it to the Vice Principal. The same will be forwarded by the Vice Principal for attendance entry. The approval of the Department of Physical Education and the class teacher is required for granting attendance related to sports. The time limit for submission mentioned above is applicable in the case of duty leave as well.

2.4.5 Condonation: A student may have the privilege of condonation of attendance shortage (up to a maximum of ten 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.

2.4.6 Re-admission: A student whose attendance is inadequate will have to discontinue the studies. Such students, whose conduct is good, may be re-admitted with the approval of the Governing Body, 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.

2.4.7 Unauthorised absence & removal from rolls: A student, absent from the classes continuously for ten consecutive working days without due intimation or permission, shall be removed from the rolls, and the matter shall be intimated to the student concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

2.5 PROGRAMME REGISTRATION

2.5.1 A student shall be permitted to register for the programme at the time of admission.

2.5.2 A PG student who registered for the programme shall complete the same within a period of eight continuous semesters from the date of commencement of the programme.

2.6 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.

2.7 EXAMINATIONS

All the end semester examinations of the college will be conducted by the Controller of Examinations. 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.

2.8 EVALUATION AND GRADING

2.8.1 Evaluation

The evaluation scheme for each course shall contain two parts:

a. **Continuous Internal Assessment (CIA)**
b. **End Semester Examination (ESE)**

25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is **1:3**, for the courses with or without practicals (except the courses offered by the School of Communications). In the case of courses offered by the School of Communications, the internal-external assessment ratio shall be **1:1**. In their case, the components for evaluation and their respective weightage shall be determined by their Board of Studies. Both internal and external evaluation shall be carried out in the grading system and the GPAs are to be rounded to two places of decimals.

2.8.2 Direct Grading: The direct grading for the components of CIA shall be based on six letter grades (A+, A, B, C, D and E) with numerical values of 5, 4, 3, 2, 1 and 0 respectively as per the following scale of accuracy/level of quality. The questions for

internal test papers and the end semester examination shall be prepared in such a way that the answers can be awarded A+, A, B, C, D and E grades.

Grade	Grade Points	Scale of accuracy/Level of quality
A+	5	Greater than or equal to 90%
A	4	80% to less than 90%
B	3	60% to less than 80%
C	2	40% to less than 60%
D	1	20% to less than 40%
E	0	Less than 20%

2.8.3 Grade Point Average (GPA): Internal and external components are separately graded and the combined GPA shall be calculated for each course with weightage **1** for internal and **3** for external.

2.8.4 Components of Continuous Internal Assessment (CIA): Grades shall be given to the evaluation of theory/practical/project/comprehensive viva-voce and all internal evaluations are based on the Direct Grading System.

a. **Components of Internal Evaluation (for theory)**

.No	Components	eightage
i.	ssignments	1
ii.	eminar	1
iii.	eld study/Industrial Visit/Viva Voce/Study Tour/Internship	1
iv.	est paper-1	1
v.	est paper-2	1
	otal	5

b. **Components of Internal Evaluation (for practical)**

Components	Weightage
Laboratory Involvement	1
Written/ Lab Test	2
Record	1
Viva Voce	1
Total	5

c. **Components of Internal Evaluation (for project)**

Components	Weightage
Relevance of the topic and analysis	2
Project content and presentation	2
Project viva voce	1
Total	5

d. **Components of Internal Evaluation (for comprehensive viva voce)**

Components	Weightage
Comprehensive viva voce (all courses from first semester to fourth semester)	5
Total	5

2.8.5 Components of End Semester Examination (ESE):

a. **For Theory**

Evaluation shall be based on the following pattern of questions:

l. No.	**ype of Questions**	**/eight**	***Number of questions to be answered**
1	Short answer type questions	1	8 out of 10
2	Short essay/problem solving type questions	2	6 out of 8
3	Long essay/problem solving type questions	5	2 out of 4

b. **For Practical**

Components of External Evaluation (for practical)

Components	Weightage
Laboratory involvement	3
Written/ Lab Test	6
Record	3
Viva Voce	3
Total	15

c. **Components of External Evaluation (for project)**

Components	Weightage
Relevance of the topic and analysis	3
Project content and presentation	7
Project viva voce	5
Total	15

d. **Components of External Evaluation (for comprehensive viva voce)**

Components	Weightage
Comprehensive viva voce (all courses from first semester to fourth semester)	15
Total	15

2.8.6 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.

2.9 PERFORMANCE GRADING

2.9.1 Students are graded based on their performance (GPA/SGPA/CGPA) at the examination on a 7 point scale as detailed below

Range	Grade	Indicator
4.50 to 5.00	**A+**	**Outstanding**
4.00 to 4.49	**A**	**Excellent**
3.50 to 3.99	**B+**	**Very Good**
3.00 to 3.49	**B**	**Good (Average)**
2.50 to 2.99	**C+**	**Fair**
2.00 to 2.49	**C**	**Marginal (Pass)**
Up to 1.99	**D**	**Deficient (Fail)**

2.9.2 No **separate minimum** is required for internal evaluation for a pass, but a minimum a '**C'** grade is required for a pass in an external examination. However, a minimum '**C'** grade is required for pass in a course and the programme as well.

2.9.3 A student who fails to secure a minimum grade '**C'** for a pass in a course shall be permitted to write the examination along with the next batch.

2.9.4 Improvement of GPA: The candidates who wish to improve the GPA of the external examinations of a course/courses can do the same by appearing in the external examination of the semester concerned along with the immediate junior batch. The facility is restricted to first and second semesters of the programme.

2.9.5 Computation of SGPA and CGPA: For the successful completion of a semester, a student should pass all the courses and score at least the minimum SGPA grade **'C'**. After the successful completion of a semester, Semester Grade Point Average (**SGPA**) of a student in that semester is calculated as the ratio of the sum of the credit points of all courses taken by a student in the semester to the total credits of that semester.

Thus, **SGPA = TCP/TCr**, where **TCP** is **Total Credit Point of that semester (** $\sum_{i=1}^{n} \mathbf{CP_i}$ **)** and **TCr is Total Credit of that semester (** $\sum_{i=1}^{n} \mathbf{Cr_i}$ **)** where '**n**' is the number of courses in that semester.

Cumulative Grade Point Average (**CGPA**) of a programme is calculated as the ratio of the sum of the credit points of all the courses of the programme to the total credits of the programme.

$$\mathbf{CGPA} = \frac{\sum(\mathbf{SGPA} \times \mathbf{TCr})}{\sum \mathbf{TCr}}$$

The SGPA/CGPA shall be rounded off to two decimal places.

For the successful completion of a programme, a student should pass all the 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.

To ensure transparency of the evaluation process, the internal assessment grade 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 assessment grade.

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.

2.10 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.

The mode of fee remittance shall be through the prescribed bank.

2.11 SUPPLEMENTARY EXAMINATIONS

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

2.12 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.

2.13 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.

2.14 RANK CERTIFICATE

Candidates shall be ranked in the order of merit based on the CGPA secured by them. Grace grade points awarded to the students shall not be counted for fixing the rank/positions. Rank certificates shall be issued to the candidates who secure positions from the first to the third in the order of merit. The position certificates shall be issued to the next seven candidates in the order of merit.

2.15 AWARD OF DEGREE

The successful completion of all the courses with **'C'** grade shall be the minimum requirement for the award of the degree.

2.16 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.

2.17 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: Level of the course teacher concerned

Level 2: 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

2.18 TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal of the college has the power to make changes in these regulations, by due orders, that shall be applied to any programme with such modifications as may be necessary on the recommendations of the Board of Studies of the respective programme.

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

Semester	Course code	Course	Teaching Hours/ week	Credit	Total Credits
I	21P1ZOOT01	Animal Diversity: Phylogenetic and Taxonomic Approaches	4	4	19
	21P1ZOOT02	Evolutionary Biology and Ethology	4	4	
	21P1ZOOT03	Biophysics, Instrumentation and Biological Techniques	3	3	
	21P1ZOOT04	Biostatistics, Digital Analytics and Research Methodology	4	4	
	21P1ZOOP01	Practical- 1	10	4	
		Total	25	19	
II	21P2ZOOT05	Field Ecology	3	3	19
	21P2ZOOT06	Genetics and Bioinformatics	4	4	
	21P2ZOOT07	Developmental Biology	4	4	
	21P2ZOOT08	Biochemistry	4	4	
	21P2ZOOP02	Practical -2	10	4	
		Total	25	19	
III	21P3ZOOT09	Animal Physiology	4	4	19
	21P3ZOOT10	Cell and Molecular Biology	4	4	
	21P3ZOOT11	Microbiology and Biotechnology	4	4	
	21P3ZOOT12	Immunology	3	3	
	21P3ZOOP03	Practical- 3	5	2	
	21P3ZOOP04	Practical -4	5	2	
		Total	25	19	
IV	21P4ZOOT13	Environmental Science- Concepts and Approaches	5	5	23
	21P4ZOOT14	Environmental Pollution and Toxicology	5	5	
	21P4ZOOT15	Environmental Management and Development	5	5	
	21P4ZOOP05	Practical -5	5	2	
	21P4ZOOP06	Practical- 6	5	2	
	21P4ZOOPR1	Project		2	
	21P4ZOOVV1	Comprehensive Viva Voce		2	
		Total	25	23	
		Grand Total			**80**
		Extra Credit Courses			
		Internship (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

21P1ZOOT01	ANIMAL DIVERSITY: PHYLOGENETIC AND TAXONOMIC APPROACHES
21P1ZOOT02	EVOLUTIONARY BIOLOGY AND ETHOLOGY
21P1ZOOT03	BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES
21P1ZOOT04	BIOSTATISTICS, DIGITAL ANALYTICS AND RESEARCH METHODOLOGY
21P1ZOOP01	PRACTICAL - 1: ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

21P1ZOOT01 - Animal Diversity: Phylogenetic and Taxonomic Approaches

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	Interpret the basic concepts of systematics and taxonomy	PO1, PO4, PO5 PSO3, PSO4	U	C	14
CO2	Identify the procedures in taxonomy and ethics in publications	PO1, PO3, PO4 PSO3, PSO4	U	C	10
CO3	Appreciate the contributions made by scientists and organisations towards conservation of animal diversity	PO3, PSO4	U	C	5
CO4	Analyze 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	Appreciate the diversity of Palaeofauna	PO1 PSO1, PSO4	U	C	5
CO6	Examine the animal architecture	PO1, PO2, PO5 PSO1, PSO2	A	C	3
CO7	Distinguish the invertebrate fauna by their characteristics	PO1, PO2, PO5 PSO2, PSO4	A	C	15
CO8	Compare 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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21P1ZOOT02 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 behaviour

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Explain the concepts of organic evolution	PO1, PO2, PO5 PSO1	U	C	5
CO2	Analyse the evidences of biological evolution	PO1, PO2, PO5 PSO1	U	C	8
CO3	Examine the process of animal evolution through studying the population genetics and ontogeny	PO1, PO2, PO5 PSO1	U	C	16
CO4	Explain the theories regarding human evolution and analyse the molecular evidences of our phylogeny	PO1, PO2, PO5 PSO1	U	C	13
CO5	Interpret the significance of studying Ethology	PO1, PO2, PO5 PSO1	U	C	3
CO6	Explain the causal factors of behaviour and different types of behaviour	PO1, PO2, PO5 PSO1	U	C	9

CO7	Illustrate the Neurophysiological aspects of behaviour	PO1, PO2, PO5 PSO1	U	C	3
CO8	Evaluate the processes underlying the expression of behaviour patterns by animals	PO1, PO2, PO5 PSO1	U	C	15

EVOLUTIONARY BIOLOGY **42 Hours**

Module I. Concepts in Evolution **5 hrs**

Concepts of variation, adaptation, struggle, fitness and natural selection, spontaneity 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 embryology – 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 ofman, African 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, supernormal 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 **3 hrs**

Goal oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives. Hormones and behaviour, Psycho-hydraulic model of motivation.

Module IV. Learning **4 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 **5 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 www.animalbehavioronline.com/modestable.html

21P1ZOOT03 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	Interpret the biophysical principles that govern the functioning of life processes.	PO1, PO2, PO5 PSO1	U	C	13
CO2	Examine the interactions of electromagnetic radiations with matter.	PO1, PO2, PO5 PSO1	U	C	4
CO3	Illustrate the techniques for studying live cells and preserved cells under the microscope.	PO1, PO2, PO5 PSO1	U	C	9
CO4	Examine the principles of chromatographic and electrophoretic separation and characterisation of biomolecules.	PO1, PO2, PO5 PSO1	U	C	12
CO5	Elaborate the technique of centrifugation and its multiple uses in studying cells and biomolecules.	PO1, PO2, PO5 PSO1	U	C	3
CO6	Discover the physics behind radioactivity measurement for medical as well as environmental dosimetry.	PO1, PO2, PO5 PSO1	U	C	2
CO7	Explain the basic principles of bio-nanotechnology and its potential in biomedical applications	PO1, PO2, PO5 PSO1	U	C	3
CO8	Interpret the principles of colorimetric, spectroscopic, and biochemical assay techniques for monitoring physico-chemical perturbations of life processes.	PO1, PO2, PO5 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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21P1ZOOT04 BIOSTATISTICS, DIGITAL ANALYTICS 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	Relate basics of statistics and measures of central tendency and dispersion	PO1, PO5 PSO3	U	C	15
CO2	Interpret correlation and regression analysis	PO1, PO5 PSO3	U	C	9
CO3	Solve probability, hypothesis testing and vital statistics	PO1, PO5 PSO3	U	C	12
CO4	Analyse the basics of computer application and software	PO1, PO5 PSO3	U	C	10
CO5	Utilize the application of SPSS and Primer6	PO1, PO5 PSO3	U	C	8
CO6	Perceive the basic concepts of research	PO1, PO2, PO5 PSO1, PSO2	A	C	5
CO7	Summarize research formulation and design	PO1, PO2, PO5 PSO2, PSO4	A	C	7
CO8	Outline 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).

DIGITAL ANALYTICS **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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21P1ZOOP01 PRACTICAL 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES, BIOSTATISTICS, DIGITAL ANALYTICS AND RESEARCH METHODOLOGY

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

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Compare and 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, PSO2, PSO3, PSO4	A	P	25
CO5	Analyse and interpret 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 o *(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

Digital analytics

- MS Excel: Preparation of table
- MS Excel: Preparation of graphs (bar, pie and ogives)
- MS Excel: Formula writing (Addition, Subtraction, 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
- Computation of Biodiversity indices using Primer6

SEMESTER II

21P2ZOOT05	FIELD ECOLOGY
21P2ZOOT06	GENETICS AND BIOINFORMATICS
21P2ZOOT07	DEVELOPMENTAL BIOLOGY
21P2ZOOT08	BIOCHEMISTRY
21P2ZOOP02	PRACTICAL - 2: FIELD ECOLOGY, GENETICS AND BIOINFORMATICS, DEVELOPMENTAL BIOLOGY, BIOCHEMISTRY

21P2ZOOT05 FIELD ECOLOGY

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	Perceive the fundamentals of ecology and environment – Physical environment, concept of homeostasis	PO1, PO3, PO4 PSO1, PSO2	U	C	6
CO2	Relate the cybernetic nature of ecosystem - feedback control & redundancy of components; resistance and resilience stability, Gaia hypothesis.	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO3	Discuss the 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	Explain the concepts of population ecology – Population group properties, growth forms, life history strategies, population structure,	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO5	Examine the concepts of population interactions and the concept of metapopulation	PO1, PO3, PO4 PSO1, PSO2	U	C	7
CO6	Explain the concepts of community - community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, guild	PO1, PO3, PO4 PSO1, PSO2	U	C	3
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- 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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21P2ZOOT06 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	Interpret the principles of Genetic Transmission	PO1,PO2 PSO1	U	C	1
CO2	Infer the Molecular Organization of Chromosomes and Fine structure of Genes	PO1,PO2 PSO1	U	C	14
CO3	Distinguish Genetic Linkage, Recombination and Chromosome mapping	PO1,PO2 PSO1	U	C	9
CO4	Perceive DNA replication and Gene Mutation	PO1,PO2 PSO1	U	C	13
CO5	Develop the concepts of Human Genetics, Extra-chromosomal Inheritance, Epigenetics, Quantitative and Population Genetics	PO1,PO2 PSO1	U	C	17
CO6	Utilize various Bioinformatics databases and their functional areas	PO1,PO2 PSO1	U	C	6
CO7	Interpret the idea of sequence similarity search and sequence analysis methodology	PO1,PO2 PSO1	U	C	6
CO8	Analyse the basic idea of Genomics, Proteomics, systems biology and metabolomics	PO1,PO2 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. Mitotic recombination. 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 therapy SCID-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 I. 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 II. Sequence Analysis 6 hrs.

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

Module III. Genomics and Proteomics 4 hrs.

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

Module IV. Systems Biology 2 hrs.

Introduction, metabolomics, gene network, synthetic biology.

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21P2ZOOT07 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

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Define gametogenesis and the process of formation of embryos, and molecular mechanisms that regulate embryo formation	PO1, PO5 PSO1,PSO4	U	C	7
CO2	Assess the process of fertilization and molecular mechanisms working for keeping the identity of species	PO1, PO5 PSO1,PSO4	U	C	8
CO3	Recall the critical nature of axis and structure formation during early embryonic life	PO1, PO5 PSO1, PSO4	U	C	15
CO4	Illustrate the factors and molecules that have critical roles in normal formation of embryos	PO1, PO5 PSO1, PSO4	U	C	10
CO5	Discuss the process of post embryonic development and regeneration	PO1, PO5 PSO1, PSO4	U	C	12
CO6	Identify the different perturbations during embryo formation	PO4, PO5 PSO1, PSO4	U	C	5
CO7	Discover the applied aspects of embryogenesis for treatment of infertility in human beings	PO4, PO5 PSO1, PSO4	U	C	5
CO8	Examine 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 - significance 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), juxtacrine 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, morphallaxis, and compensatory. Mechanism of epimorphic 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 Pleiotropy; 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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21P2ZOOT08 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

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Examine the structure and classification of different biomolecules – protein, lipid, carbohydrate and nucleic acid.	PO1 PSO1	U	C	24
CO2	Discuss the metabolic pathways of different biomolecules	PO1 PSO1	U	C	20
CO3	Evaluate the disorders of the biomolecules	PO1 PSO1	U	C	10
CO4	Outline the different enzymes and its kinetics	PO1 PSO1	U	C	6
CO5	Summarize the biological roles of biomolecules	PO1 PSO1	U	C	4
CO6	Ellaborate 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 amino acids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different amino acids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan, Phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome, sickle cell anaemia.

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. Reactions; Hydrolysis, 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.

Coenzymes, iso-enzymes, ribozymes. 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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21P2ZOOP02 PRACTICAL 2: FILED ECOLOGY,GENETICS AND BIO-INFORMATICS, BIOCHEMISTRY, DEVELOPMENTAL BIOLOGY

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

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Compare and study different types of ecosystems, food web, food chain, bio geo chemical cycles, qualitative and quantitative estimation of planktons.	PO1,PO2, PO3,PO4, PO5 PSO2, PSO3, PSO4	A	P	30
CO2	Apply and study conductivity, ph. ,Applications of instruments, field study report	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	30
CO3	Organise and study mutants, sexing and culture of Drosophila, phylogenetic tree, gene prediction.	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4			40
CO4	Estimate and study quantitative and qualitative estimations in Biochemistry	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	40
CO5	Evaluate and study basic techniques in developmental biology and studies on embryos.	PO1,PO2, PO3,PO4, PO5, PSO2, PSO3, PSO4	A	P	40
					180

Filed 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

21P3ZOOT09	ANIMAL PHYSIOLOGY
21P3ZOOT10	CELL AND MOLECULAR BIOLOGY
21P3ZOOT11	MICROBIOLOGY AND BIOTECHNOLOGY
21P3ZOOT12	IMMUNOLOGY
21P3ZOOP03	PRACTICAL - 3: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY
P3ZOOP04	PRACTICAL - 4: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

21P3ZOOT09 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 overview 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	Explain and compare the functioning of organ systems across the animal world	PO1,PO2, PO4 PSO1	U	F	7
CO2	Illustrate the mechanism of regulating food intake in human beings as well as problems related with overeating and resultant obesity	PO1,PO2 PSO1	U	C	10
CO3	Explain the structure of different types of hearts in animals, and examine the functioning of respiratory and circulatory systems of human beings together with their diseases	PO1,PO2 PSO1	U	C	10
CO4	Explain the osmoregulatory and excretory systems of human body and the factors regulating these processes	PO1,PO2 PSO1	U	C	12
CO5	Outline the functioning of neurons, nerves and muscles	PO1,PO2 PSO1	U	C	13
CO6	Illustrate the structure of sense organs and the transduction processes which convert changes in physical/chemical environment into nerve signals	PO1,PO2 PSO1	U	C	8
CO7	Examine the mechanism of thermoregulation in human body	PO1,PO2 PSO3	U	C	4
CO8	Analyze the chemical coordination system of animal body and examine the reproductive physiology in relation to endocrinology of mammals	PO1,PO2 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, ampullary heart, lymph heart, neurogenic and myogenic heart. Pacemakers and specialized conducting fibers. Cardiac cycle, cardiac output, blood pressure, effect of drugs on heart beat, effects of exercise on cardiovascular 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 an 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 freshwater, 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.

Module VII. 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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21P3ZOOT10 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	Appreciate the role played by various cell organelles and cytoskeleton	PO1, PO2 PSO1, PSO4	U	C	11
CO3	Analyze the role played by cell signalling pathways	PO1, PO2 PSO1, PSO4	U	C	15
CO4	Describe the process involved in cell cycle and molecules involved	PO1, PO2 PSO1, PSO4	U	C	7
CO5	Distinguish between a cancerous cell from non-cancerous one	PO1, PO2 PSO1, PSO4	U	C	8
CO6	Examine the concept of gene expression	PO1, PO2 PSO1, PSO4	A	C	10
CO7	Discuss 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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21P3ZOOT11 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	Perceive the basic concepts of microbiology – Methods, classification, functional anatomy of prokaryotic cells	PO1, PO3, PO4 PSO1, PSO2	U	C	6
CO2	Discuss the advanced concepts of microbial metabolism, nutrition, growth, interactions and ecology	PO1, PO3, PO4 PSO1, PSO2	U	C	11
CO3	Discuss the advanced concepts of virology	PO1, PO3, PO4 PSO1, PSO2	U	C	3
CO4	Explain 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	Perceive 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	Extend 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. Culture media. 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- $CaCl_2$ 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: $CaPO_4$ 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 Property Rights, 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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21P3ZOOT12 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	Explain the overview of immune system	PO1,PO4, PO5 PSO1	U	F	3
CO2	Outline antigens and antibodies and their interactions	PO1,PO4, PO5 PSO1, PSO4	U	C	10
CO3	Explain the complement system	PO1,PO4, PO5 PSO1, PSO4	U	C	5
CO4	Classify and interpret the Immune effector mechanisms	PO1,PO4, PO5 PSO1, PSO4	U	C	5
CO5	Explain about allergy and hypersensitivity	PO1,PO4, PO5 PSO1	U	C	4
CO6	Explain about the Major Histocompatibility Complex (MHC)	PO1,PO4, PO5 PSO1, PSO4	U	C	8
CO7	Explain the mechanism of immune reactions behind health problems and diseases	PO1,PO4, PO5 PSO1,PSO4	U	C	15
CO8	Explain and intepret 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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21P3ZOOP03 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

21P3ZOOP04 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	Examine 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 the 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	Demonstrate the separation of lymphocytes from whole blood; Separation of T and B lymphocytes; Blood Typing in Man.	PO1, PO2, PO3, PO4, PO5, PSO2, PSO3, PSO4	A	P	8
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

21P4ZOOT13	ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES
21P4ZOOT14	ENVIRONMENTAL POLLUTION AND TOXICOLOGY
21P4ZOOT15	ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT
21P4ZOOP05	ENVIRONMENTAL SCIENCE PRACTICAL - 1
21P4ZOOP06	ENVIRONMENTAL SCIENCE PRACTICAL - 2

21P4ZOOT13 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	Examine the concepts of physical environment – Lithosphere, atmosphere and hydrosphere	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Explain the fundamental and advanced concepts of weather and climate	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO3	Outline the climate of India	PO1, PO3, PO4 PSO1, PSO2	U	C	4
CO4	Examine the concepts of Landscape ecology	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO5	Explain the concepts of Biodiversity and Conservation	PO1, PO3, PO4 PSO1, PSO2	U	C	24
CO6	Evaluate the major environmental and conservation laws and rules as well as illustrate the biogeography of India.	PO1, PO3, PO4 PSO1, PSO2	U	C	12
CO7	Examine the concepts of biological invasions	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO8	Evaluate 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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21P4ZOOT14 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	Summarize the concepts of pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Examine the air and water pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	27
CO3	Evaluate the sources and the factors affected by soil pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	25
CO4	Design 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	Elaborate the concepts of noise, thermal and oil pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO6	Define the concepts of Radiation pollution	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO7	Explain the definition, doses and toxic chemicals in the environment	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO8	Summarize 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. Bioaccumulation 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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21P4ZOOT15 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	Discuss the principles of environmental management, modelling and auditing	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Discuss the fundamental and advanced concepts of environmental management concepts	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO3	Describe environmental planning, ecoremediation and restoration	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO4	Examine 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	Examine the concepts EIA documentation, types of impact assessment, SEA, CIA, SIA	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO6	Evaluate 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	Discuss 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 Division for Sustainable Development - *Rio+20 working papers*

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.

Westman W.E 1995. *Ecology, Impact Assessment and Environmental Planning*. John Wiley and sons. NY,USA.

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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

21P4ZOOP05 ENVIRONMENTAL SCIENCE PRACTICAL - 1

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

CO	CO Statement	POs/PSOs	CL	KC	Class sessions
CO1	Explain the concepts of physical environment – Lithosphere, atmosphere and hydrosphere	PO1, PO3, PO4 PSO1, PSO2	U	C	18
CO2	Outline the fundamental and advanced concepts of weather and climate	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO3	Summarize the climate of India	PO1, PO3, PO4 PSO1, PSO2	U	C	4
CO4	Classify the concepts of Landscape ecology	PO1, PO3, PO4 PSO1, PSO2	U	C	8
CO5	Compare and Contrast the concepts of Biodiversity and Conservation	PO1, PO3, PO4 PSO1, PSO2	U	C	24
CO6	Explain the major environmental/conservation laws and rules and biogeography of India	PO1, PO3, PO4 PSO1, PSO2	U	C	12
CO7	Explain the concepts of biological invasions	PO1, PO3, PO4 PSO1, PSO2	U	C	10
CO8	Explain 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.

21P4ZOOP06 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

References

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Jayaram, K. C. (2010) *The Freshwater Fishes of the Indian Region*, Narendra Publishing House, New Delhi

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MODEL QUESTION PAPERS

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 1
MODEL QUESTION PAPER
21P1ZOOT01: Animal Diversity: Phylogenetic and Taxonomic Approaches

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. Describe 'Type' in taxonomy.
2. What is Alpha taxonomy?
3. What is binomial nomenclature?
4. Distinguish between Synonymy and Homonomy.
5. Explain the concept t'Tree of Life'.
6. What is a taxonomic monograph?
7. Define 'Trilobites'
8. Discuss on the importance of 'cephalization'
9. Summarize the role of ZSI.
10. What is Cambrian explosion?

(8 X 1= 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Explain numerical taxonomy.
12. Examine the ethics in taxonomy.
13. Outline the types of taxonomic keys.
14. Describe three domain concepts in Taxonomy.
15. Explain the evolutionary importance of hemichordates
16. Evaluate on 'Bar coding of life'.
17. Discuss on the importance of 'Fauna of British India series'.
18. List out the contributions of Sir Francis Day & Sunder Lal Hora.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Discuss on the ICZN – importance and main rules.
20. Discuss on Mesozoic reptiles and possible reasons for their extinction.
21. Explain the structural and functional adaptations of birds.
22. Elaborate the Geography, Faunal diversity and endemism of Western Ghats.

(2 X 5 = 10)

M.Sc. DEGREEENDSEMESTER EXAMINATION
ZOOLOGY– SEMESTER 1
MODEL QUESTION PAPER
21P1ZOOT02: Evolutionary Biology and Ethology

Time: 3Hours Max. Weight: 30

Part A

(Answer any 8questions. Each question carries a weight of 1)

1. Recall Panspermia?
2. Outline co-evolution?
3. What are tidal rhythms?
4. What are the advantages of altruism?
5. Discover the advantages of chemical communication.
6. What is Prosimii?
7. Discuss the contributions of Margulis
8. Compare Darwin's finches
9. What is Y-chromosomal Adam?
10. Explain the concept of Oparin-Haldane.

(8 X 1= 8)

Part B

(Answer any 6questions. Each question carries a weight of 2)

11. Citing Pavlov's experiment, explain classical conditioning
12. Explain biological rhythms influenced by the lunar cycle with examples.
13. Elucidate adaptive radiation in mammals
14. Explain the evolution of unicellular eukaryotes.
15. Summarize the evolution of communication
16. Explain the different types of Plasticity
17. Explain the concept of Urey –Miller.
18. Discuss the origin of photosynthesis and aerobic metabolism.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Explain the various aspects of Evo-Devo Genetics
20. Define communication. Explain different methods of animal communication.
21. Define fossils. Explain fossilization and its significance.
22. Elaborate the neurophysiological aspects of behaviour

(2 X 5 = 10)

M.Sc. DEGREEENDSEMESTER EXAMINATION
ZOOLOGY– SEMESTER 1
MODEL QUESTION PAPER
21P1ZOOT03: BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES

Time: 3Hours Max. Weight: 30

Part A

(Answer any 8questions. Each question carries a weight of 1)

1. Define the term ‘Osmosis’?
2. What is 'Photoelectric effect'?
3. Define 'Relative retention time'.
4. Give two examples of cation and anion exchanger.
5. Outline ‘Disc gel electrophoresis’.
6. What are the applications of 'Affinity chromatography'?
7. Explain the specimen preparation protocol for SEM
8. What do mean by exocytosis?
9. Recall Fick’s law of diffusion.
10. What is 'ELISA'?

(8 X 1= 8)

Part B

(Answer any 6questions. Each question carries a weight of 2)

11. Explain the biological effects of ionizing radiation.
12. Explain the technique of PAGE.
13. Discuss the various centrifugation techniques.
14. Differentiate between spectrophotometry and colorimetry.
15. Explain Gibbs-Donnan equilibrium.
16. Explain the various types of Spectroscopy.
17. Discuss the methods for detection of proteins and carbohydrates.
18. Explain the histochemical method for the detection of nucleic acids.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Explain the principle, method and applications of HPLC.
20. Discuss the chemiosmotic theory and ATP synthesis.
21. Evaluate the different modes of interaction of radiation with matter.
22. Elaborate the principle and applications of Transmission electron microscope.

(2 X 5 = 10)

M. Sc. DEGREE ENDSEMESTER EXAMINATION
ZOOLOGY – SEMESTER 1
MODEL QUESTION PAPER
21P1ZOOT04: Biostatistics, Digital Analytics and Research Methodology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. What are cartograms?
2. Difference between frequency polygon and ogive.
3. What is *z*- test?
4. Define arithmetic mean. What are advantages of mean over median?
5. What do you mean by positive and negative correlation?
6. What is meant by software?
7. What is GUI?
8. Explain the terms 'Modem' and 'Gateway'
9. Why 'Bioethics' is a relevant term ?
10. What is pseudo science?

(8 X 1= 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Calculate the median for following series.

size of shoe in inches	4	5	6	7	8	9
frequency	10	15	22	16	12	5

12. Explain ANOVA and its application in biology.
13. Define and compare three commonly used measures of dispersion –the range, the interquartile range and standard deviation.
14. Analyse the coefficient of correlation in the following case

Height of father (in nches)	65	66	67	67	68	69	71	73
Height of son (in inches)	67	68	64	68	72	70	69	70

15. What is operating system? Briefly write on any two of them
16. Compare on computer viruses and antiviruses
17. Summarize notes on intellectual property right
18. Outline on research extension? Explain with examples.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Summarize on probability distributions? Describe role of Poisson distribution in probability modelling?
20. Solve mean, median and mode from the following data

Class Interval	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
Frequency	4	12	40	41	27	13	9	4

21. Explain computer networking. Discuss the advantages and disadvantages of it.
22. Illustrate on experimental design? Explain the steps involved in experimental design.

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 2
MODEL QUESTION PAPER
21P2ZOOT05: Field Ecology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. Differentiate between resistance stability and resilience stability of ecosystem
2. Explain Allee's principle
3. Differentiate ecotone and edge effect.
4. What are Ramsar sites? Give two examples in India.
5. Which are the major minerals that occur in India? Comment on its availability.
6. What is territoriality?
7. Differentiate between *r* and *k* selection.
8. Briefly describe ecological succession.
9. State the first law of thermodynamics.
10. Define energy audit

(8 X 1= 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Explain Gaia hypothesis.
12. Describe the concept of meta-population.
13. Explain growth forms and carrying capacity
14. What are the possible ways to achieve sustainable development? Discuss.
15. Explain guilds and its functioning in community
16. Discuss the importance of wetlands.
17. Discuss the causes and consequences of wetland reclamation
18. Describe the cybernetic nature of ecosystem

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Explain population interactions
20. Discuss the drivers of species diversity loss
21. Describe the mineral resources and mineral wealth of India
22. Discuss biomass and productivity measurement.

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 2
MODEL QUESTION PAPER
21P2ZOOT06: Genetics and Bioinformatics

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. What are alleles?
2. What are Lampbrush chromosomes?
3. Explain Wobble hypothesis.
4. Summarize on IS elememts.
5. What is QTL mapping.
6. What is Complementation test.
7. What is Theta replication.
8. Compare on EMBL and DDBJ.
9. Comment on Entrez.
10. Outline on SWISSPROT.

(8 X 1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Build an account on chromosomal mutations.
12. Outline the molecular mechanism of eukaryotic replication.
13. Comparative account on biological databases.
14. Summarize on data mining in proteomics.
15. Justify the holiday model.
16. Evaluate the molecular analysis of quantitative traits.
17. Elucidate the methods for sequence alignment.
18. Make an account on structural genomics.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Examine the DNA replication process and outline it.
20. Summarize on repetitive sequences and its importance.
21. Support and solve the molecular basis of gene mutation.
22. Defend your idea on the molecular organization of chromosomes.

(2 X 5 = 10)

M Sc DEGREE ENDSEMESTER EXAMINATION
ZOOLOGY – SEMESTER 2
MODEL QUESTION PAPER
21P2ZOOT07: Developmental Biology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. Define Nieuwkoop centre
2. Explain cell lineage
3. Describe polyspermy?
4. Differentiate midblastula transition
5. Explain Spermiogenesis?
6. Define Autophene
7. Point out neoteny?
8. Comment on homeotic selector genes
9. Illustrate Pleiotrophy?
10. Explain competence

(8 X1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Specify the molecular process of Fertilization
12. Define Parthenogenesis with suitable examples
13. Explain the process of Oogenesis.
14. Examine the causes of infertility in man.
15. Evaluate the early development and axis formation in *C. elegance*.
16. Explain RTK - pathway of signal transduction
17. Describe various transcription factors involved in early development.
18. Identify the different types of regeneration.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Describe Spermatogenesis.
20. Assess the hormonal control of metamorphosis in Amphibia
21. Summarize the process of gene regulation
22. Justify teratogenesis with suitable examples.

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 2
MODEL QUESTION PAPER
21P2ZOOT08: BIOCHEMISTRY

Time: 3 Hours Max. Marks: 75

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. List out the biological importance of lipids.
2. Define 'pK value' of amino acids.
3. Explain how free radicals are formed within cells.
4. Distinguish between α helix and β helix in the secondary structure of proteins.
5. Define 'Saponification number'?
6. What is 'Terpenes'.
7. What are restriction endonucleases?
8. Compare the 'Polenske number' and 'Reichert-Meissl number' of lipids.
9. List out two essential amino acids.
10. Describe any two reactions of monosaccharides.

(8 X1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Examine 'Glycogen storage diseases'.
12. Explain Ramachandran map.
13. Discuss the structure of prostaglandins.
14. Describe the structure of DNA.
15. What are essential fatty acids and non essential fatty acids? Give examples.
16. Explain glycogenesis.
17. Summarize on biosynthesis of triglycerides.
18. Describe mode of action of enzymes.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Explain the structure and importance of heteropolysaccharides.
20. Discuss on the fate of carbon skeletons of amino acids.
21. Outline the process of regulation of glycogen metabolism.
22. Elaborate the various protein-nucleic acid interaction.

(2 X 5 = 10)

M.Sc. DEGREEENDSEMESTER EXAMINATION
ZOOLOGY– SEMESTER 3
MODEL QUESTION PAPER
21P3ZOOT09: Animal Physiology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8questions. Each question carries a weight of 1)

1. What is symbiotic digestion?
2. What is circulatory shock and circulatory arrest ?
3. Define cardiac cycle?
4. Recall surfactants ?
5. List excretory products
6. What is neuromuscular junction?
7. Define Poikilothermy and Homeothermy
8. Differentiate between electrolyte balance and acid base balance?
9. What is meant by balanced diet?
10. Explain thermoreceptors

(8 X 1 = 8)

Part B

(Answer any 6questions. Each question carries a weight of 2)

11. Examine the causes and consequences of obesity
12. Elucidate the principle and significance of ECG
13. Discuss the regulation of respiration
14. Compare red and white muscles
15. Explain the mechanism of osmoregulation in freshwater animals
16. With suitable diagram, explain the structure of nephron.
17. Summarize tactile sensation.
18. Differentiate between smooth muscles and cardiac muscles

(6 X 2 = 12)

Part C

(Answer any 2 questions. Eachquestion carries a weight of 5)

19. Explain the physiology and regulation of urine formation
20. Illustrate the ultra structure and molecular organization of skeletal muscle
21. Elaborate the reproductive cycles of mammals and their hormonal control
22. Explain the effect of exercise on respiration and cardiovascular system

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 3
MODEL QUESTION PAPER
21P3ZOOT10: Cell and Molecular Biology

Time: 3 Hours Max. Weight: 30

Part A
(Answer any 8 questions. Each question carries a weight of 1)

1. Explain the process of Osmosis
2. What is Sodium - Potassium pump?
3. Explain G- protein coupled receptor
4. What are carrier proteins?
5. Describe Riboswithces?
6. What are hemidesmosomes?
7. Define oncogenes
8. Explain the role of Mitochondria
9. Define Peroxisomes
10. Describe Genetic code

(8 X 1 = 8)

Part B
(Answer any 6 questions. Each question carries a weight of 2)

11. Describe the mechanism of gene regulation in E - coli.
12. Explain the role of RNA interference in gene regulation.
13. Elaborate JAK-STAT pathway.
14. Describe the gap junction
15. Outline the properties of cancer cells
16. Explain the structure of Golgi bodies
17. Distinguish between mitosis and meiosis
18. Explain the structure and function of Endoplasmic reticulum.

(**6 X 2 = 12)**

Part C
(Answer any 2 questions. Each question carries a weight of 5)

19. Examine the structure of the cell membrane.
20. What are second messengers? Explain their role in cell signal transduction.
21. Elaborate the interaction of cells with other cells
22. Discuss on transcription in prokaryotes and eukaryotes.

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 3
MODEL QUESTION PAPER
21P3ZOOT11: Microbiology and Biotechnology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 6 questions. Each question carries a weight of 1)

1. Define Nosocomial infections
2. Differentiate between pili and fimbriae
3. What are Prions? Mention their significance.
4. Distinguish between gram positive and gram negative cell walls
5. Distinguish between viroids and satellites
6. What is chromosome walking?
7. Define biopesticides
8. Comment on DNA vaccines
9. What are Biosensors? Explain their role in medicine.
10. Comment on GATT

(8 X 1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Explain interactions between microbes and animals with examples.
12. What is Bioterrorism? Comment on biological weapons.
13. Comment on oncovirus and oncoviral mechanisms
14. Describe the structure of T4 bacteriophage
15. Explain the biotechnology of nitrogen fixation
16. Discuss the methods of stem cell culture and describe its applications.
17. Give an account of DNA sequencing methods.
18. Give biosafety protocol 2000

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Describe the ultra structure of bacterium with suitable illustrations
20. Discuss the microbiology of milk and dairy products
21. Describe the sewage and solid waste treatment management
22. Write an essay on molecular markers and their applications in modern biology.

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 3
MODEL QUESTION PAPER
21P3ZOOT12: Immunology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 Questions. Each question carries a weight of 1)

1. Differentiate between active and passive immunity.
2. What are haptens?
3. Define adjuvants.
4. Explain SLE.
5. What is HLA typing?
6. Define cross reaction.
7. What is CD4+ T cell?
8. Explain serum sickness
9. Define Innate immunity.
10. Briefly explain RAST.

(8 X 1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Distinguish between innate and acquired immunity.
12. Differentiate between epitope and paratope.
13. Differentiate between scavenger and toll like receptors.
14. Give a brief account on monoclonal antibodies and abzymes.
15. Explain the regulation of complementary system.
16. Outline the therapeutic use of cytokines.
17. Briefly explain MHC and graft rejection.
18. Explain ELIZA.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Explain various types of vaccines.
20. Discuss humoral and cell mediated immune response.
21. Describe general organization and inheritance of MHC.
22. Describe clinical manifestation of graft rejection.

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 4
MODEL QUESTION PAPER
21P4ZOOT13: Environmental Science – Concepts and Approaches

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. Distinguish between core and crust
2. What is Lithosphere?
3. What are soil colloids?
4. Give a brief note on plate tectonics.
5. Differentiate between weather and climate?
6. Explain water logging.
7. Distinguish between empty niche and novel weapon hypothesis.
8. Discuss on People's participation in conservation.
9. Distinguish between landscape and habitat.
10. Discuss the role of GEF in conservation.

(8 X 1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Describe the role of microbes in soil.
12. Classify climate.
13. Explain the process of weathering and soil formation.
14. Describe the physico - chemical aspects of estuaries.
15. Discuss on monsoon in Kerala and its significance.
16. Compare and contrast natural and urban landscapes.
17. Describe the patterns of biodiversity
18. Briefly explain biodiversity indices

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Explain hydrological cycle and its role in the maintenance of life on earth.
20. Discuss the significance of Western Ghats
21. Describe ecological land degradation.
22. Describe values of biodiversity

(2 X 5 = 10)

M Sc DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 4
MODEL QUESTION PAPER
21P4ZOOT14: Environmental Pollution and Toxicology

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 questions. Each question carries a weight of 1)

1. Explain the Threshold Limit Value (TLV)?
2. Define teratogenicity.
3. How is BOD significant in determining water quality standards?
4. Comment on carbon trade.
5. Distinguish between acute and chronic toxicity.
6. List the primary pollutants of air?
7. Outline about the occupational hazards.
8. What is a bio digester? How it functions?
9. Explain IPCC.
10. Illustrate the bio transformation of xenobiotics.

(8 X 1 = 8)

Part B

(Answer any 6 questions. Each question carries a weight of 2)

11. Differentiate between bio accumulation and bio-magnification.
12. Explain Activated Sludge Treatment.
13. Describe how constructed wetlands can be used for water treatment.
14. Analyze the hazards and management methods of e-waste.
15. Discuss the parameters of air quality determination?
16. Examine bioremediation is an effective tool for controlling pollution
17. Identify the toxic chemicals present in the environment.
18. Explain the concepts of bioindicators

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Elucidate the advanced methods of waste water treatment.
20. How can bioindicators be used to monitor the quality of environment?
21. Examine the soil pollution in highlands and wetlands of Kerala with case studies.
22. Elaborate the quantities, characteristics and processing of MSW

(2 X 5 = 10)

M. Sc. DEGREE END SEMESTER EXAMINATION
ZOOLOGY – SEMESTER 4
MODEL QUESTION PAPER
21P4ZOOT15: Environmental Management and Development

Time: 3 Hours Max. Weight: 30

Part A

(Answer any 8 Questions. Each question carries a weight of 1)

1. Distinguish between Rapid EIA and comprehensive EIA?
2. What is alternatives in EIA, give an example
3. Define LCA.
4. What is calyx expert system?
5. Examine the spectral characteristics of surface features.
6. Evaluate the environmental modeling techniques.
7. Distinguish between CSR and CER.
8. Discuss on Eco-labelling.
9. Describe MDG.
10. Explain the management practices for mining areas.

(8 X 1 = 8)

Part B

(Answer any 6 Questions. Each question carries a weight of 2)

11. What is base line data, mention the importance of baseline data collection in EIA study?
12. Explain tool box for environmental management.
13. Discuss the five basic laws of ecology.
14. Examine the management practices for grasslands and wetlands.
15. Discuss the role of satellites in conservation.
16. Evaluate critically the pros and cons of modern agriculture.
17. Summarize the ISO standards for environment management.
18. Explain ecological foot print analysis.

(6 X 2 = 12)

Part C

(Answer any 2 questions. Each question carries a weight of 5)

19. Discuss on the principles and concept of remote sensing.
20. Discuss India's national policy on EIA with suitable examples.
21. Evaluate critically the concept of sustainable development and the current trends.
22. Examine the modern agriculture and green revolution

(2 X 5 = 10)