SACRED HEART COLLEGE
Autonomous

CURRICULUM AND SYLLABI

CHOICE BASED CREDIT SYSTEM

(CBCS-PG)

M.Sc. ZOOLOGY PROGRAMME

INTRODUCED FROM 2016 ADMISSION ONWARDS

BOARD OF STUDIES IN ZOOLOGY

Sacred Heart College, Thevara, Kochi, Kerala

SACRED HEART COLLEGE AUTONOMOUS THEVARA, KOCHI-682013 1944

Dr. Jose John
Principal in Charge
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Thevara, Kochi-682 013

Report of the Board of Studies

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The BOS meeting held on 03/12/2015, Friday at 2.30 PM in the department discussed and aproved the final revised syllabus for the M. Sc. Zoology Programme wef 2016- 2017 admisions.

CONTENTS

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CURRICULUM

1. **SCOPE**

1.1. These regulations provided herein shall apply to M.Sc. Zoology programme, conducted by Sacred Heart College (S.H.college), Thevara with effect from the academic year 2016-2017 admission onwards.

2. **DEFINITIONS**

2.1 'Academic **Committee'** means the Committee constituted by the principal under this regulation to monitor the running of the Post-Graduate programmes under the Choice Based Credit System (CBCS-PG).

2.2 'Programme' means the entire course of study and examinations.

2.3 'Duration **of Programme'** means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be of 4 semesters.

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

2.5 '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 / seminar / project / practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

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

2.7 '**Programme Credit'** means the total credit of the PG Programmes, ie; **80 credits**.

2.8 '**Programme Core course'** Programme Core course means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

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

2.10 '**Programme Project'** Programme Project means a regular project work with stated credits on which the student undergo 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.

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

2.12 '**Tutorial'** Tutorial means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

2.13 '**Seminar'** seminar means a lecture expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

2.14 '**Evaluation'** means every course shall be evaluated by 25% internal assessment and 75% external assessment.

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

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

2.17 '**Department'** means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.

2.18 '**Parent Department'** means the Department which offers a particular Post graduate programme.

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

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

2.21 '**College Co-ordinator** means a teacher from the college nominated by the College Council to look into the matters relating to CBCS-PG System

2.22 'Letter Grade' or simply '**Grade**' in a course is a letter symbol (S, A, B, C,

D, etc.) which indicates the broad level of performance of a student in a course.

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

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

2.25 **'Extra credits'** are additional credits awarded to a student over and above the minimum credits required for a programme for achievements in co-curricular activities carried out outside the regular class hours as directed by the College.

2.26 '**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 taken by him/her in that semester . The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

2.27 **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.

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

2.29 'Words **and expressions'** used and not defined in this regulation but defined in the Mahatma Gandhi University Act and Statutes shall have the meaning assigned to them in the Act and Statute.

3. **ACADEMIC COMMITTEE**

3.1 There shall be an Academic Committee constituted by the principal to manage and monitor the working of (CBCS-PG) 2016.

3.2 The Committee consists of

(a) The principal

(b) The vice principal

(c) Deans of the faculties of science, arts and commerce

(d) The Controller of Examinations

(e) The superintendent of the college

4. PROGRAMME STRUCTURE

4.1 Students shall be admitted into post graduate programmes under the various faculties.

4.2 The programme shall include two types of courses, Program Core (C) courses and Program Elective (E) Courses. There shall be a Program Project (D) with dissertation to be undertaken by all students. The Programme will also include assignments, seminars, practical (P), viva (V)etc., if they are specified in the Curriculum

4.3 There shall be various groups of four Programme Elective courses for a programme such as Group A, Group B etc. for the choice of students subject to the availability of facility and infrastructure in the institution and the selected group shall be the subject of specialization of the programme.

4.4 Project work

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

4.4.2 Project work shall be carried out under the supervision of a teacher in the concerned department.

4.4.3. 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.

4.4.4 There should be an internal assessment and external assessment for the project work in the ratio 1:3

4.4.5 The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce.

4.4.6 The mark and credit with grade awarded for the program project should be entered in the grade card issued by the college.

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

4.6 Seminar Lecture: Every PG student may deliver one seminar lecture as an internal component for every course. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

4.7 Every student shall undergo **two class tests** as an internal component for every course.

4.8 The attendance of students for each course shall be another component of internal assessment.

4.9 Comprehensive Viva-voce shall be conducted at the end semester of the programme which covers questions from all courses in the programme.

5. ATTENDANCE

5.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of Post Graduate programme may be granted by the University.

5.2 If a student represents the college in University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union / University union activities, he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of 10 days in a Semester based on the specific recommendations of the Head of the concerned Department and Principal of the College.

5.3 A student who does not satisfy the requirements of attendance shall not be permitted to take the end Semester examinations.

5.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch

6. **BOARD OF STUDIES AND COURSES.**

6.1 The PG Board of Studies in Zoology shall design all the courses offered in the PG programme. The Boards shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposures and training for the students.

6.2 The syllabus of a course shall include the title of the course, contact hours,

the number of credits and reference materials.

6.3 Each course shall have an alpha numeric code number which includes abbreviation of the subject in two letters, the semester number, the code of the course and the serial number of the course ('C' for Program Core course, 'E' for Program Elective course, 'O' for Open Elective course, 'P' for Practical and 'D' for Project/ Dissertation and 'V' for Comprehensive Viva voce).

6.4 Every Programme conducted under Choice Based Credit System shall be monitored by the College Council.

7. **REGISTRATION**.

7.1 A student shall be permitted to register for the programme at the time of admission. The duration of the PG Programme shall be 4 semesters.

7.2 A student who registered for the course shall complete the course within a period of 8 continuous semesters from the date of commencement of the programme.

8. **ADMISSION**

8.1 The admission to all PG programmes shall be as per the rules and regulations of the college.

8.2 The eligibility criteria for admission shall be as announced by the college from time to time.

8.3 There shall be provision for inter collegiate and inter University transfer within a period of two weeks from the date of commencement of the semester.

8.4 There shall be provision for credit transfer subject to the conditions specified by the Board of Studies concerned.

9. ADMISSION REQUIREMENTS

9.1 Candidates for admission to the first semester of the PG programme through CBCS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of the college as equivalent thereto.

9.2 The candidate must forward the enrolment form to the Controller of Examinations of the college through the Head of the Institution.

9.3 The candidate has to register all the courses prescribed for the particular semester. Cancellation of registration is applicable only when the request is made within two weeks from the time of admission.

9.4 Students admitted under this programme are governed by the Regulations in force.

10. .**PROMOTION**: A student who registers for the end semester examination shall be promoted to the next semester

11. EXAMINATIONS

11.1 There shall be an external examination at the end of each semester.

11.2 The answers must be written in **English** except for those coming under Faculty of languages.

11.3 Practical examinations shall be conducted by the college at the end of the semesters as per the syllabus.

11.4 Project evaluation and Comprehensive Viva -Voce shall be conducted at the end of the programme only. Practical examination, Project evaluation and Comprehensive Viva-Voce shall be conducted by two external examiners.(For professional courses, one examiner can be opted from the same college itself)

11.5 There shall be one end-semester examination of 3 hours duration in each lecture based course (Theory).

11.6 A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different marks, but a general pattern may be followed by the Board of Studies.

12 **EVALUATION AND GRADING**

12.1 Evaluation: The evaluation scheme for each course shall contain two parts; (a) internal evaluation (ISA) and (b) external evaluation (ESA). 25 marks shall be given to internal evaluation and 75 marks to external evaluation so that the ratio between internal and external mark is 1:3. Both internal and external evaluation shall be carried out in mark system. Both internal and external marks are to be mathematically rounded to the nearest integer.

12.2 Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The marks assigned to various components for internal evaluation is a follows.

12.3 Components of Internal Evaluation

All the components of the internal evaluation are mandatory

a) For Theory

	Components	**Marks**
i.	Assignment	5
ii	Seminar/Quiz/Field survey etc.	5
iii	Attendance	5
iv	Two Test papers(2x5)	10
	Total	25

b) For Practical

Components	**Marks**
Attendance	5
Written/Lab test	5
Laboratory Involvement/ Record*	10
Viva	5
Total	**25**

*Marks awarded for Record should be related to number of experiments recorded

c) For Project

Components	**Marks**
Topic/Area selected	2
Experimentation/Data collection	5

Punctuality	3
Compilation	5
Content	5
Presentation	5
Total	**25**

12.4 Evaluation of

Attendance

% of attendance	Mark
Above 90%	5
Between 85 and < 90	4
Between 80 and below 85	3
Between 76 and below 80	2
75	1

Assignment

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

Seminar

Components	**Marks**
Content	2
Presentation	2
Reference/Review	1
Total	**5**

12.5 To ensure transparency of the evaluation process, the internal

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

12.6 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 Principal and a copy should be kept in the college for at least two years for verification.

12.7 End-semester Examination: The end-semester examination in theory courses shall be conducted by the college with question papers set by external experts. The evaluation of the answer scripts shall be done by the examiners based on a well defined scheme of evaluation given by the question paper setters. The external evaluation shall be done immediately after the examination preferably through the centralised valuation.

12.8 The question paper should be strictly on the basis of model question paper set by BoS and there shall be a combined meeting of the question paper setters for scrutiny and finalisation of question paper. Each set of question should be accompanied by its scheme of valuation.

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

Percentage of Marks	Grade	Grade Point (GP)
95 and above	O Outstanding	10
85 to below 95	A^+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B^+ Good	7
55 to below 65	B Above Average	6

45 to below 55	C Average	5
40 to below 45	D Pass	4
Below 40	F Fail	0
	Ab Absent	0

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

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

12.10 A **separate minimum of 40% marks** (D grade) required for a pass for both internal evaluation and external evaluation for every course.

12.11 A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the end semester examination for the same semester, subsequently.

12.12 A student who fails to secure a minimum marks/grade for a pass in a course will be permitted to write the examination along with the next batch.

There will be no improvement examinations

12.13 After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of semester, a student should pass all courses and score a minimum SGPA of 4.0 However, a student is permitted to move to the next semester irrespective of her/his SGPA.

Credit Point (CP) of a course is calculated using the formula
CP = Cr x GP, where Cr = Credit; GP = Grade point
Semester Grade Point Average (SGPA) of a Semester is calculated using the formula
SGPA = TCP/TCr, where
TCP = Total Credit Point of that semester = $\sum_1^n \mathrm{CPi}$;

TCr = Total Credit of that semester = $\sum_1^n \mathrm{Cri}$
Where n is the number of courses in that semester
Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula

$$CGPA = \frac{\sum(TCP \times TCr)}{\sum TCr} \; GPA \; shall \; be \; round \; off \; to \; two \; decimal \; places$$

12.14 PATTERN OF QUESTIONS

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

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

Pattern of questions for external examination for theory paper

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

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

13. **GRADE CARD**

The colleges under its seal shall issue to the students, a grade card on completion of each semester, which shall contain the following information.

a) Name of the College

b) Title of the Postgraduate Programme

c) Name of the Semester

d) Name and Register Number of the student

e) Code, Title, Credits and Max. Marks (Internal, External & Total) of each course(theory& Practical) in the semester.

f) Internal, External and Total Marks awarded, Grade, Grade point and Credit point in each course in the semester

g) The total credits, total marks (Max. & Awarded) and total credit points in the semester

h) Semester Grade Point Average (SGPA) and corresponding Grade.

i) Cumulative Grade Point Average (CGPA)

j) The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses(theory & practical) taken during the final semester examination and shall include the final grade/marks scored by the candidate from 1st to 3rd semester, and the overall grade/marks for the total programme.

14. **AWARD OF DEGREE**

The successful completion of all the courses with 'D' grade (40%) shall be the minimum requirement for the award of the degree

15**. MONITORING COMMITTEE**

There shall be a Monitoring Committee constituted by the principal to monitor the internal evaluations conducted by college. The Course teacher, Faculty Advisor, and the College Coordinator should keep all the records of the internal evaluation, for at least a period of two years, for verification.

16. GRIEVENCE REDRESSAL MECHANISM

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

Level 1: At the level of the concerned course teacher

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

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

17. **TRANSITORY PROVISION**

Notwithstanding anything contained in these regulations, the Vice-Chancellor shall, for a period of three year from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary

18. **REPEAL**

The Regulations now in force in so far as they are applicable to programmes offered by the college and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Choice Based Credit System in their application to any course offered in a College, the latter shall prevail.

Distribution of course and credit are given in the following table.

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

	P4ZOOP06	Practical- 6	5	2	
	P4ZOOPR1	Project		2	
	P4ZOOVV1	Comprehensive Viva Voce		2	
		Total	25	23	
		Grand Total			**80**
		Extra Credit Courses			
		Training in Spider Taxonomy		1	
		Training in Marine Biotechnology		1	
		Training Animal Rearing		1	

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SYLLABUS

M.Sc. ZOOLOGY Programme

SEMESTER I

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

ZY1CT01 - BIOSYSTEMATICS AND ANIMAL DIVERSITY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

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

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. Higher categories – Genus, family, order, class and phylum (brief account only) 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 **15 hrs.**

(Details on individual species not expected)

An overview of Animal Diversity in India, Corals of India, Earthworm diversity of India, Commercial Shrimps and Prawns of India, Insect fauna of India, Butterflies of India, Indian Arachnids, Indian molluscs, Echinoderms of India, Major fishes of India, Amphibian diversity of India, Indian snakes, Survey of Indian Bird fauna, Indian mammals, Diversity of domesticated animals of India, Endangered animals of India, An overview of Animal Diversity of Kerala, 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, fossil protists, Edicaran and Burgess Shale fauna. Cambrain explosion- causes and consequences. Fossil arthropods - Trilobites, Extinct molluscs, Fossil Echinoderms, Fossil records of Fishes, Mesozoic world of reptiles and their extinction. Fossil record of birds, Mammalian ancestral forms, Animal fossil records from India.

Module IV.Animal architecture **2 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; Recent trends in the classification of protists. Body architecture of sponges, Diversity of Porifera with reference to body structure. Diversity of Cnidaria with reference to body organization and morphology. Ctenophoran diversity. Acoelomata, Placozoa, Mesozoa and Pseudocoelomata; Phylogeny of Arthropod - Monophyly and Polyphyly, Reasons for the success of Arthropods. Diversity of arthropod larvae; Adaptive Radiation in Molluscs, Larval forms of Molluscs; Lesser Protostomes (Brief account only) - Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha, Echinoderms -

Adaptive radiation, Larval forms of Echinoderms. Hemichordates – Taxonomic position.

Module III. Animal Diversity – Vertebrates 6 hrs.

Lower Chordates, Chondrichthyes and Osteichthyes, Modern Amphibians, diversity, distribution, status and threats, Reptiles – origin and adaptive radiation, Birds **-** Structural and functional modifications for aerial life, Adaptive radiation in mammals.

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P1ZOOT02 EVOLUTIONARY BIOLOGY AND ETHOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

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

EVOLUTIONARY BIOLOGY 41 Hours

Module I. Concepts in Evolution 3 hrs.

Concepts of variation, adaptation, struggle, fitness and natural selection- spontaneity of mutation and the evolutionary synthesis. Contributions of Margulis, 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, genome evolution. Anaerobic metabolism- origin of photosynthesis and aerobic metabolism.

Module III. Evidences of Evolution 8 hrs.

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

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

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

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

Module IV. Population Genetics 10 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. Co-evolution.

Module V. Developmental and Evolutionary Genetics 4 hrs.
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 VI. Primate Evolution and Human Origins 8 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. Evolution of human brain- communication, speech and language.

ETHOLOGY 31 Hours

Module 1. Introduction 1 hr.
Historical background, Stimulus-Response, Causal factors, Quantitative aspects - Duration, interval frequency. Behaviour bouts. Scope of ethology.

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

Module III. Motivation – Definition 2 hrs.
Goal oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives.
Hormones and behaviour, Psycho-hydrologic 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 VI. Reproduction and Behaviour 4 hrs.
Reproductive strategies, Mating systems, Courtship, Sexual selection- patterns, parental care and investment.

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, co-operation, territoriality, alarm call, social organization in insects and primates.

Module IX. Stress and Behaviour **2 hrs.**
Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance.

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Web Resources
http://www.talkorigins.org
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Web Resources

www.animalbehavioronline.com/modestable.html

P1ZOOT03 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

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 **7 hrs.**

Paper chromatography,Thin layer chromatography, Ion exchange chromatography.

Gel permeation chromatography,Affinity chromatography,Gas chromatography High pressure liquid chromatography (HPLC).

Module III. Electrophoresis **5 hrs.**

Paper electrophoresis,Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) - SDS and non SDS , Disc electrophoresis, High voltage electrophoresis, immunoelectrophoresis.

Module IV. Colorimetry, Spectrophotometry and Spectroscopy **5 hrs.**

Principle and applications of colorimetry and spectrophotometry.

Spectroscopy :Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic- resonance spectroscopy (NMR).

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 **2 hrs.**

Dosimetry: Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography.

Module VII. Nanotechnology **3 hrs.**

Introduction to Nanobiology. Nanosensors and Nanomedicines.

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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P1ZOOT04 BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

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

BIOSTATISTICS 30 hrs.

Module 1. Basics of Biostatistics 4 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 4 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 3 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 3 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 **3 hrs.**
Introduction, uses, records and system of classification of vital statistics.
Sample registration system, Sample design, Survey of causes of death and Age classification. Measures of Vital Statistics and Measures of Population (Mortality rates, Fertility rates).
Life tables (Brief account only).

COMPUTER APPLICATIONS **23 hrs.**

Module I. Basics of Computers **10 hrs.**
Generations of computers, Organization of computers, Binary Number System and Digital Computers. Hardware – examples, Software - System Software, Operating System – functions, DOS, Widows, Linux and UNIX (Brief account only), Application Softwares, Firmware, Virus and Antivirus (Brief account only). Types of modern computing: Cluster computing, Grid computing, cloud computing (Basics only).

Module II. Computer Language and Programming **5 hrs.**
Computer languages -Classification and types, HTML, C and Java
Programming concepts -Algorithm, Codes (Basics only).

Module III. Information Technology and Biology **8 hrs.**
Computer Networking – structure, topology, types (PAN, LAN, WAN, MAN) Wireless communication – Bluetooth /Wifi (Basics only).
INFLIBNET – Library networking
Internet and Internet Services -World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines, Firewall.
Biological Databases – Category, role in biological research, Brief account on - BIOSIS, Medline and Medlars, AGRIS;
E Journals and E Books Publishing.
Cyber Crime and Cyber Laws (Brief account only).

RESEARCH METHODOLOGY 19 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 -Theory, Principle, Law and Canon.

Module IV. Research Designs 4 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, e-Encyclopedia, 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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P1ZOOP01 PRACTICAL 1: BIOSYSTEMATICS AND ANIMAL DIVERSITY, EVOLUTIONARY BIOLOGY AND ETHOLOGY, BIOPHYSICS, INSTRUMENTATION AND BIOLOGICAL TECHNIQUES, BIOSTATISTICS, COMPUTER APPLICATION AND RESEARCH METHODOLOGY

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

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 + 5^0C) of water in a microenvironment and preparation of an ethogram.

Study of the grooming behaviour in insects/bird

Biophysics/Instrumentation/Biological Techniques

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

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

TLC using amino acids from purified samples and biological materials.

Gel electrophoresis (protein/nucleic acid)

Biostatistics

(Problems can be solved using scientific calculator).

Calculation of Pearson correlation coefficient.

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

Calculation of Chi square value (2x2 table only)

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

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

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

Computer Applications

MS Excel: Preparation of table

MS Excel: Preparation of graphs (bar, pie and ogives)

MS Excel: Formula writing (Addition, Substraction, Multiplication, Division, Power and Root)

MS Excel: Correlation Analysis

PH Stat: Basic statistics (mean, median, mode, standard deviation), Chi square test, Students t test, Regression

SEMESTER II

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

P2ZOOT05 ECOLOGY: PRINCIPLES AND PRACTICES

54 Hours (3 hrs/week) **Credit – 3**

Objectives:

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

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. Primary productivity, Biomass and productivity measurement. Biogeochemical cycles- patterns and types (CNP). Tropical versus Temperate Ecology.

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.

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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P2ZOOT06 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

GENETICS **54 hrs.**

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

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 **4 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.
DNA damage and repair mechanisms

Module VI. DNA Replication **9 hrs.**

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

Module VII. Human Genetics **5 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.

Module VIII. Extra Chromosomal Inheritance **2 hrs.**

Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

Module IX. Epigenetics **5 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.

Module X. Quantitative and Population Genetics **5 hrs.**

Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, QTL mapping, genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity .

BIOINFORMATICS **18 hrs.**

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

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez;
Database sequence submission – BankIt.

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

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

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

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

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

Introduction, metabolomics, gene network, synthetic biology.

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P2ZOOT07 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

Module I. Early development at molecular level **15 hrs.**

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

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

Significance of axis formation in embryonic patterning – anterior posterior, dorsal ventral, left right axes. Axis formation in amphibian development – Spemann's constriction experiments, transplantation experiments. Embryonic induction, competence – Spemann organizer, Nieuwkoop centre and mesodermal signalling, Molecular basis of mesoderm induction, inducer molecules associated with organizer such as paracrine factors (FGF factors, Hedgehog proteins, Wnt proteins, TGF – β factors, BPM proteins), justacrine factors, transcription factors, role of these molecules in development. 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.
Regenaration – different types; stem cell mediated, epimorphosis, morpholaxis, and compensatory. Mechanism of epimorhic regeneration in Salamander leg, Morphollactic regeneration in Hydra, Compensatory regeneration in mammalian liver. Lens regeneration in amphibia.

Module V. Teratogenesis **5 hrs.**

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

Module VI. Applied aspects of Developmental Biology 5 hrs.

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

Module VII. Stem cells 10 hrs.

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

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P2ZOOT08 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

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. 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 III. Lipids **10 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 steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins.

Prostaglandins- structure, types, synthesis and functions.

Module IV. Nucleic Acids **10 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 V. Enzymes **6 hrs.**

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

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

Module VI. Carbohydrate Metabolism **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 VII. Metabolism of Proteins **8 hrs.**

Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different aminoacids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan.

Module VIII. Metabolism of Lipids **6 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 IX. Nucleic Acid and Mineral Metabolism **8hrs.**

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.

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

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

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/O-Toluidine/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

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

P3ZOOT09 ANIMAL PHYSIOLOGY

72 Hours (4 hrs/week) **Credit – 4**

Objectives:

- To study and compare the functioning of organ systems across the animal world
- To give an over view of the comparative functioning of different systems in animals
- To learn more about human physiology

Module I. Nutrition **5 hrs.**

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

Module II. Circulation **8 hrs.**

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

Module III. Respiration **6 hrs.**

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

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

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

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

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

Module VI. Sensory and Effector Physiology 8 hrs.

Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, modality of sensation, secondary sense cells, transduction, relationship between stimulus, intensity and response, sensory coding. Chemical senses: taste, smell, mechanism of reception.

Mechanoreceptors: hair cell, organs of equilibrium, vertebrate ear, mechanism of hearing, electro and thermoreceptors.

Physiology of vision.

Pain: pain receptors, headache and thermal senses, pain suppression (analgesia).

Tactile sensation: touch receptors, transmission of signals, special problems of premature infants, Physiological role of touch and environment in premature infants- Kangaroo care, infant massage, supportive environment.

ModuleVII. Muscle Physiology 5 hrs.

Red and white muscles, muscle proteins. Effect of exercise on muscles. Catch muscle and fibrillar muscle.

Module VIII. Thermoregulaion 4 hrs

Comfort zone, body temperature - physical, chemical, neural regulation, acclimatization.

Impact of temperature on the rate of biological functions.

Temperature compensation and temperature regulation in poikilotherms and homiotherms. Adaptations for extreme environments.

Module IX. Endocrinology 15 hrs.

Invertebrate and vertebrate endocrine system. Endocrine glands.

Synthesis, physiologic role, control and mechanisms of hormone action. Neuro-endocrine 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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P3ZOOT10 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

Module I. Cellular Membranes **6 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, with extracellular matrix,

Chemical nature of Extracellular matrix (Brief account only), Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. 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, Vesicular transport of secretory products, Lysosomes - Role in autophagy, 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 **13 hrs.**

An overview of cell signaling system, Extracellular messengers (signaling molecules) Cell surface Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors (Tyrosine kinase linked receptors).

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

Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway –GPCR pathway in sensory perception, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, Calcium phosphatidyl- inositol pathway, Phospho Inositide 3-kinase (PI-3 kinase).

Regulation of signaling pathways - Convergence, divergence and crosstalk among different pathways.

Module VI. Cellular Reproduction **4 hrs.**

Cell cycle: Steps in cell cycle, Control of cell cycle, Checkpoints in cell cycle. Control of cell division and cell growth.

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, RNA processing in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes, initiation, elongation and termination, post transcriptional modifications

Module XI. Gene Regulation **12 hrs.**

Gene regulation in prokaryotes - *Lac operon,* Catabolite repression, *Trp* operon - repression and attenuation. General introduction to gene regulation in eukaryotes at transcriptional, post transcriptional and translational levels, Chromatin-remodelling complexes, Riboswitches, RNA interference (RNAi).

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P3ZOOT11 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

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

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P3ZOOT12 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

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 cell-mediated 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. MHC-peptide 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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P3ZOOP03 PRACTICAL - 3: CELL AND MOLECULAR BIOLOGY, MICROBIOLOGY AND BIOTECHNOLOGY

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

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 using 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) pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture
- (c) serial dilution and standard plate count, calculation of Cfu/ml in water samples.

Isolation and preservation of bacterial culture.
Identification of microorganisms-
- (a) Staining techniques- gram staining of mixed cultures, negative staining and spore staining.

Antibiotic sensitivity (different natural fluids)
- (a) Oxidase test
- (b) Catalase test
- (c) Oxidation/fermentation (O/F) test

Staining and enumeration of microorganisms:
- (a)using haemocytometer
- (b) nephelometry/ Turbidimetry

Environmental sample analysis.
- a) Coliform count in water
- b) Isolation and enumeration of soil bacteria
- c) Identification of symbiotic bacterioids from root nodules of leguminous plants

Bacteriological analysis of milk- methylene blue reductase test.

P3ZOOP04 PRACTICAL - 4: ANIMAL PHYSIOLOGY AND IMMUNOLOGY

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

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
Observation on the effect of decreasing PO_2 of water on the respiratory rate of a fish and determination of the lactic acid content of the muscle
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

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

P4ZOOT13 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

Module I. The Physical Environment **20 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 **12 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 VII. 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; In-vitro 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 VIII. 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 IX. Biogeography **6 hrs.**

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

Module X. 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.

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P4ZOOT14 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

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.

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.

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 land fills 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 rersponsibility.

Module V. Noise, Thermal and Oil Pollution **7 hrs.**

Properties of sound and noise. Effects of noise on People and ecosystem. Basic principles of noise control. National and International Standards. Assessment and measurement of sound.

Thermal Pollution-causes and consequences

Oil pollution – causes and consequences (any two case studies).

Module VI. Radiation Pollution **8 hrs.**

Radiation pollution- Definition, Radioactivity, Radionuclide, Radiation emissions, sources, Radioactive decay and buildup. Biological effects of radiation. Radioactive pollution impacts on ecosystem. Nuclear reactor disasters (Any two case studies), safety standards.

Module VII. Toxicology **20 hrs.**

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

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

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

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

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

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

Bio-transformation of Xenobiotics (Selective Toxicity).

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Oehme, W.F. 1989. *Toxicity of Heavy Metals in Environment.* Marcel Dakkar Inc., New York.

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P4ZOOT15 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

Module I. Environmental Management **20 hrs.**

Basic principles: Management of physical, social, and economic environment. Concepts and scope of environmental planning, regional planning and management. Cost-benefit analysis and Resource economics.

Environmental modeling- simulation modeling, input-output modeling, Linear programming, Software and resource management.

Tool box for environmental management – An over view of Ecological foot prints, carbon footprint, Water foot print, Happy Planet Index (HPI), Ecological Economics, conflict resolution strategies. Eco funds.

Environmental auditing and standards, Eco labeling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental management systems (EMS) ISO 14000 family of standards, 14001 and 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 **10 hrs.**

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

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

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Web Resources

www.moef.gov.in (of Ministry of Environment and Forests, Govt. of India)

www.millenniumassesment.org. (for Millennium Ecosystem Assessment Synthesis Reports)

www.unep.org

http://www.un.org/sustainabledevelopment

P4ZOOP05 ENVIRONMENTAL SCIENCE PRACTICAL - 1

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

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)
Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, eveness and diversity indices *(This can be done as part of the three / four day field study incorporated in Practical-2).*

P4ZOOP06 ENVIRONMENTAL SCIENCE PRACTICAL - 2

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

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).
Isolation and Enumeration of microorganisms in soil (TBC or TMC).
Bacteriological quality testing of water and wastewater.
(a). Presumptive coliform test
(b). Confirmatory coliform test

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).*

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