

**ST. TERESA'S COLLEGE (AUTONOMOUS)
ERNAKULAM**

Affiliated to Mahatma Gandhi University, Kottayam



**CURRICULUM FOR
M. Sc. ZOOLOGY**

**Under Credit & Semester System
(2025 Admissions Onwards)**

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM
BOARD OF STUDIES IN ZOOLOGY

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Department of Zoology,
St. Teresa's College (Autonomous), Ernakulam

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- 8. Dr. Helvin Vincent** : **Member**
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- 9. Dr. Reema Kuriakose** : **Member**
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- 10. Dr. Keziya James** : **Member**
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- 11. Dr. Jean Mary Joy** : **Member**
Assistant Professor,
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12. Ms. Jemma Pius

: Member

Assistant Professor,
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St. Teresa's College (Autonomous), Ernakulam

13. Ms. Arya Ashok

: Member

Assistant Professor,
Department of Zoology
St. Teresa's College (Autonomous), Ernakulam

**MINUTES OF THE BOARD OF STUDIES MEETING OF THE
DEPARTMENT OF ZOOLOGY HELD ON 18/03/2025**

This is to certify that the revised syllabus of the M. Sc. ZOOLOGY for 2025 admissions onwards has been scrutinized and approved at the Board of Studies Meeting which was held on (18/03/2025). The complete revised syllabus of M. Sc. ZOOLOGY programme was presented before the Board of Studies and discussed in detail. The revised syllabus was approved by the Board of Studies.

The following members attended the meeting.

- 1. Dr. Soja Louis** : **Chairperson**
Associate Professor and Head,
Department of Zoology,
St. Teresa's College (Autonomous), Ernakulam

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: Member

Assistant Professor,
Department of Zoology,
St. Teresa's College (Autonomous), Ernakulam

**Chairperson
Board of Studies in Zoology**

**FACULTY OF THE DEPARTMENT WHO HAVE CONTRIBUTED
TOWARDS CURRICULUM AND SYLLABUS IN M. Sc. ZOOLOGY**

Dr. Soja Louis

Associate Professor and Head,
Department of Zoology,
St. Teresa's College (Autonomous), Ernakulam

Dr. Meera Jan Abraham

Associate Professor,
Department of Zoology,
St. Teresa's College (Autonomous), Ernakulam

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Assistant Professor,
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St. Teresa's College (Autonomous), Ernakulam

ACKNOWLEDGEMENT

I acknowledge with gratitude all the guidance and help given by our Directors, Rev. Sr. Tessa CSST and Rev. Sr. Francis Ann CSST and Principal, Prof. Dr. Alphonsa Vijaya Joseph during the course of restructuring the syllabus of M. Sc. Zoology. I also remember and acknowledge with gratitude all the members of the Board of Studies for their constructive suggestions and contributions in restructuring of all the courses of this Masters Programme. I thank Dr. Vidya Panicker Coordinator of the PG syllabus restructuring in Zoology. I thank all the faculty members of the Department, for taking great effort to prepare this syllabus. I am also grateful to all the members of the Curriculum Committee of the college for their guidance during the syllabus framing process. Above all, I bow my head before God Almighty for all the guidance he has continuously given to us in all our endeavours.

Dr. Soja Louis

Chairperson, Board of Studies in Zoology

St. Teresa's College (Autonomous), Ernakulam

PREFACE

As an autonomous institution under Mahatma Gandhi University, St. Teresa's College is committed to enhancing its curriculum while adhering to the essential guidelines set by the University and Higher Education Council. Our aim is to cultivate a well-rounded educational experience. Within the framework of the prescribed syllabi, we have unified our efforts to foster an inspiring academic environment that empowers both teachers and students to delve deeper into knowledge and contribute to its dissemination and growth. It is crucial to emphasize that the generation and sharing of Quality Knowledge—which is vital for the growth and development of students and society as a whole—constitute the core mission of any educational institution.

The revised syllabi of our programs are designed in such a way to offer students innumerable opportunities for authentic, real-world learning experiences that will enhance their reasoning, creativity, intelligence and problem-solving abilities. This approach will enable them to attain knowledge of universal significance and relevance, fostering personal growth, civic responsibility, economic proficiency and the overall welfare of community, society and world at large.

We would like to acknowledge the dedication of our teachers in restructuring the syllabi and defining course outcomes that prioritize the cognitive and intellectual development of our learners. This initiative instils the confidence necessary for them to conduct independent and scholarly research in their areas of professional interest, positioning them as effective global cross-cultural educators.

We extend our congratulations to the Prof. Dr. Alphonsa Vijaya Joseph, Principal, Dr. Kala M.S., Dean of Self Financing, Dr. Mary Liya C.A, Faculty Coordinator for syllabus revision, who have effectively coordinated the syllabus restructuring across all programs. We strive to transform lives and make a meaningful impact both locally and globally through the creation, sharing, and application of knowledge. We look forward to sharing the outcomes of our curriculum restructuring and hope that these resources will inspire reflection on the advancements in learning within our institution, as well as contribute to the global educational landscape.

Sr. Tessa CSST & Sr. Francis Ann CSST

Directors, St. Teresa's College (Autonomous), Ernakulam

FOREWORD

Autonomy in higher education signifies a commitment to responsibility and accountability, which ultimately fosters excellence in academics and proactive governance. St. Teresa's College was granted autonomous status in 2014, and since then, we have made concerted efforts to uphold a high standard of quality in the education we provide. In 2019, the college achieved re-accreditation by NAAC with an A++ grade (CGPA 3.57).

This academic autonomy has empowered us to refine our syllabus to meet the evolving needs of today's students. The current educational landscape presents numerous challenges, and it is essential that our curricula and syllabi reflect the significant shifts occurring across various disciplines. To this end, we have gathered structured feedback from students, alumni and industry experts, incorporating their suggestions into our syllabi.

Our Board of Studies, established for each department, meets regularly within the designated timeframe to engage in thorough discussions regarding various aspects of the curricula and syllabi. The IQAC team has facilitated numerous workshops and conferences to equip our faculty with the necessary skills to design syllabi and formulate question papers for internal assessments, ensuring that the learning outcomes outlined in the syllabus are met and that examinations are conducted fairly and transparently.

The responsibilities that come with our autonomy are indeed substantial, but we have united in our efforts to tackle the challenges that arise. Our focus has been on shaping young women into responsible citizens who will contribute to nation-building in exemplary ways. To enhance industry-academia linkage and ensure students are placement-ready, the curriculum will emphasize the importance of internships and application-oriented research projects, fostering a sense of social responsibility and equipping students with practical skills to facilitate entrepreneurship. We are dedicated to nurturing their academic aspirations alongside their skills in co-curricular activities. To align with the needs of the new generation of students, we plan to restructure our postgraduate programs in the upcoming academic year.

I extend my heartfelt gratitude for the unwavering support and guidance provided by Rev. Sr. Tessa CSST and Rev. Sr. Francis Ann CSST, the Directors of the College. I would also like to express my special thanks to the team led by Dr. Kala M.S and Dr. Mary Liya C.A. for coordinating the syllabus restructuring of our programs, as well as to the Heads of Departments

and all faculty members for their dedication, commitment and exceptional contributions to this important initiative.

PROF. ALPHONSA VIJAYA JOSEPH
PRINCIPAL

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PREAMBLE

The aim of the Postgraduate education is to provide high quality education as well as a supportive learning environment for the students to reach their full academic potential. The higher education has to inculcate in students the spirit of hard work and research aptitude to pursue further studies in the nationally/internationally reputed institutions as well as prepare them for a wider range of career opportunities in interdisciplinary fields.

The Board of Studies in Zoology has restructured the syllabi for M. Sc. Zoology so as to monitor, review and enhance educational experience which ensures that the Post Graduate Education remains intellectually demanding and relevant to current needs of Zoology graduates. The thrust is given in fostering a friendly and stimulating learning environment which will motivate the students to reach high standards, enable them to acquire real insight into Zoology and become self-confident, committed and adaptable graduates. With this in mind, we aim to provide a firm foundation in every aspect of Zoology and to develop analytical, experimental, computational, logical and reasoning skills of students.

The Board of Studies acknowledges and appreciates the good effort put in by the faculty members of the Department of Zoology to restructure the syllabus for M. Sc. Zoology in the institution which will be implemented for the admissions from 2025 onwards.

PROGRAMME OUTCOMES (POs) OF POSTGRADUATE PROGRAMMES:

The integration of Outcome-Based Education (OBE) stands as a cornerstone of the postgraduate programmes at St. Teresa's College (Autonomous), Ernakulam, with the Programme Outcomes (POs) intricately aligned to the vision and mission of the college. By adopting OBE, the institution meticulously cultivates graduates who are not only equipped with advanced knowledge and critical skills but are also adept in addressing professional challenges, contributing to society, and embracing lifelong learning, thereby fostering well-rounded, responsible individuals committed to excellence in their fields. The POs for the post graduates of St. Teresa's college are listed below:

PO1: Advanced Knowledge and Application

Graduates will demonstrate an advanced and integrated understanding of their discipline, to effectively apply this knowledge to solve complex, real-world challenges, showing originality in developing innovative solutions that contribute to their field and to society.

PO2: Critical Thinking and Analytical Skills

Graduates will critically evaluate complex problems, synthesize information from diverse sources, and employ advanced analytical reasoning to formulate evidence-based solutions in line with contemporary needs.

PO3: Research and Innovation

Graduates will be able to conduct independent, original research using appropriate scientific or creative methodologies, thereby contributing new knowledge or insights to implement innovative practices and provide solutions to the issues of contemporary world.

PO4: Interdisciplinary and Collaborative Skills

Graduates will collaborate effectively in interdisciplinary and multicultural teams, leveraging the strengths of various disciplines to address multifaceted problems, reflecting the global best practice of professionals who can operate in diverse group settings.

PO5: Communication Skills

Graduates will be skilled in articulating their ideas, research findings, and solutions clearly and effectively in both oral and written formats, ensuring engagement and understanding across diverse audiences.

PO6: Technological Proficiency and Innovation

Graduates will be proficient in using modern technologies and digital tools relevant to their field, applying technological innovations to enhance research, professional practice, and societal well-being, and ensuring they remain at the cutting edge of their discipline.

PO7: Global Awareness and Societal Engagement

Graduates will integrate knowledge of global trends, cultural diversity, and sustainable development principles into their work, actively engaging with society to promote inclusivity, equity, and environmental stewardship in line with global citizenship values.

PO8: Ethical and Professional Responsibility

Graduates will uphold the highest standards of ethics and professionalism in all their academic and professional endeavours and will make informed decisions that reflect integrity and ethical consideration, including respect for diverse perspectives and awareness of the social and environmental implications of their actions.

PO9: Advocacy for Social Justice and Inclusive Development

Graduates will leverage their knowledge, skills, and experiences to advocate for social justice, equality, and the empowerment of marginalized communities, engaging in initiatives that promote inclusive and sustainable development, thereby contributing to the well-being of society.

PO10: Lifelong Learning and Professional Development

Graduates will embrace a mindset of lifelong learning, continually adapting to new technologies and societal needs by proactively seeking new learning opportunities and adapt to emerging technologies and evolving industry trends, engaging in ongoing professional development to remain at the forefront of their field.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The M. Sc. Zoology programme prepares graduates to achieve key objectives within a few years of completion, focusing on professional success, societal contributions, and lifelong learning. The Programme Educational Objectives (PEOs) of M. Sc. Zoology programme, outlined below, are designed to equip graduates with the skills and knowledge for continued growth and advancement in the field of Zoology.

PEO1: Postgraduates will secure successful careers in core zoological fields or allied sectors like biotechnology and environmental consultancy, applying their molecular biology expertise.

PEO2: Postgraduates will demonstrate proficiency in academic research and industry roles, utilizing advanced molecular techniques to address challenges in genetics, ecology, and disease biology.

PEO3: Postgraduates will uphold the highest ethical standards in research, contributing to projects addressing genetic research, conservation, or sustainability issues, with a focus on societal and environmental implications.

PROGRAMME SPECIFIC OUTCOME (PSOs)

The Department of Zoology is committed to provide an enriched educational experience to develop the knowledge, skills and attributes of students to equip them for life in a complex and rapidly changing world.

On completion of the M. Sc. Zoology our students should be able to demonstrate the programme outcomes listed below:

PSO1: Explain fundamental knowledge and skills in animal taxonomy, phylogenetic systematics, evolutionary biology, genetics, animal physiology, cell biology, and apply ecological and statistical principles to address environmental concerns (U).

PSO2: Describe physiological adaptations, development, reproduction, and behaviour across different life forms, and integrate bioethical considerations in the study and application of molecular biology (U).

PSO3: Discuss the applications of biochemistry, biotechnology, biophysics, bioinformatics, molecular immunology, microbiology, and cancer biology, with a focus on emerging technologies and genomic sequencing (U).

PSO4: Apply advanced molecular methodologies, assess high-throughput technologies, and interpret biostatistical data to determine their impact on human health and the environment. (A).

PSO5: Apply various methods and understanding of subject to conduct research projects, demonstrate proficiency in competitive examinations, pursue entrepreneurial opportunities, and establish connections with industry to facilitate real-world applications and innovation (A).

JOB OPPORTUNITIES

M. Sc. Zoology graduates have diverse career opportunities in academia, research, healthcare, wildlife conservation and industry. They can work as educators, researchers, biotechnologists, environmental consultants and wildlife officers. Government roles, entrepreneurship in aquaculture and bio-industries and science communication also offer promising careers.

ELIGIBILITY FOR ADMISSION

Graduation in Zoology

Candidates who have passed qualifying examination in CBCSS (2009) pattern should possess CGPA of not less than 2.00 out of 4.00 in the Core Group (core plus open and complementary courses).

Candidates who have passed qualifying examination in CBCSS (2013) pattern should possess CGPA of not less than 5.00 out of 10.00 in the Core Group (core plus open and complementary courses).

Candidates who have passed qualifying examination in other patterns should possess not less than 50% marks in main & subsidiary subjects under Part III.

Relaxation:

For **SC/ST candidates** - The minimum grade in the qualifying examination for admission to the PG Degree programmes is 'C' in the seven-point scale for CBCSS and a pass for pre-CBCSS applicants.

For **OEC candidates** - A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 1.80 for CBCSS (2009), CCPA of 4.5 for CBCSS (2013) applicants and 45% marks for pre-CBCSS applicants.

For **SEBC candidates** - A relaxation of 3% marks in the qualifying examination from the prescribed minimum is allowed. i.e. CGPA of 1.88 for CBCSS (2009), CGPA of 4.7 for CBCSS (2013), applicants and 47% marks for pre-CBCSS applicants.

For **Physically disabled candidates** - A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 1.80 for CBCSS (2009), CCPA of 4.5 for CBCSS (2013) applicants and 45% marks for pre-CBCSS applicants.

Duration of the Programme: Four Semesters

Examination: Credit and Semester system (CSS)

Direct Grading system with 7 point scale

Medium of instruction and assessment: English

Faculty under which the Degree is awarded: Faculty of Science

PROGRAMME STRUCTURE

STRUCTURE OF M. Sc. ZOOLOGY

The programme shall include two types of courses, Core courses and Elective courses. There shall also be a Project and Comprehensive Viva Voce as core courses. The programme also includes assignment/ seminar/ Class tests etc. The total credit for the programme is fixed at 80.

THEORY COURSES

There are **fifteen** theory courses spread equally in all the four semesters of the M. Sc. Programme. Distribution of theory courses is as follows. There are twelve core courses common to all students. Semester I, Semester II and Semester III will have **four** core courses each and Semester IV will have **three** elective courses as an elective bunch. The college shall select one elective bunch from among three elective bunches as per the interest of the students, availability of faculty and academic infrastructure.

PRACTICAL

All four semesters will have a course on laboratory practical. The practical examinations will be conducted at the respective examination centres by one external and one internal examiner appointed by the controller of examinations at the end of each semester.

PROJECT

The project of the PG programme should be relevant and innovative in nature. The type of project can be decided by the student and the guide (a faculty of the department or other department/college/university/institution). The project work should be taken up seriously by the student and the guide. The project should be aimed to motivate the inquisitiveness and research aptitude of the students. The students may be encouraged to present the results of the project in seminars/symposia. The conduct of the project may be started at the beginning of Semester III, with its evaluation scheduled at the end of Semester IV along with the practical examination as being practiced in the present syllabus. The project is evaluated by external and internal examiners.

COMPREHENSIVE VIVA VOCE

A comprehensive viva voce examination will be conducted by the external and internal examiners at the time of evaluation of the project. The viva voce examination is given a credit of two. The components of viva consists of subject of special interest, fundamental Zoology, topics covering all semesters and awareness of current and advanced topics.

COURSE CODE

The courses in the programme are coded according to the following criteria. The first two letters of the code indicates the name of programme, ie. ZO stands for Zoology. Next digit is to indicate the semester. i.e., ZO1 (Zoology, 1st semester). This is followed by the letter C or E indicating whether the course is a core course or elective course as the case may be. (However, in the case of Project/Comprehensive viva voce this letter is omitted.) Next two digits indicate the course number (avoided in the case of Project/Comprehensive viva voce). The letter/letters T/P/PR/V follows it and is used to indicate theory/ practical/ project/ viva. The next letter will be M which indicates that the programme is for masters. The last two digits 25 represent the year in which restructuring is done.

Example: Theory- ZO1C01TM25 and for Practical ZO1C01PM25.

DISTRIBUTION OF COURSES AND CREDITS

Semester	Course Code	Course Title	Teaching hours per week (T + P)	Credit	Total credit
I	ZO1C01TM25	Animal Diversity: Phylogenetic and Taxonomic Approaches	4	4	19
	ZO1C02TM25	Evolutionary Biology and Ethology	4	4	
	ZO1C03TM25	Biochemistry	4	4	
	ZO1C04TM25	Biostatistics and Research Methodology	3	3	
	ZO1C01PM25	Animal Diversity, Evolutionary, Ethological, Biochemical and Biostatistical Methods and Approaches	10	4	
		TOTAL	15+10=25	19	
II	ZO2C05TM25	Ecology: Principles and Practices	4	4	19
	ZO2C06TM25	Developmental Biology	4	4	
	ZO2C07TM25	Genetics and Bioinformatics	4	4	
	ZO2C08TM25	Microbiology	3	3	
	ZO2C02PM25	Methods and Approaches in	10	4	

		Ecology, Developmental Biology, Genetics, Bioinformatics and Microbiology			
		TOTAL	15+10=25	19	
III	ZO3C09TM25	Animal Physiology	4	4	19
	ZO3C10TM25	Cell Biology	4	4	
	ZO3C11TM25	Biophysics, Instrumentation and Biological Techniques	4	4	
	ZO3C12TM25	Biotechnology	3	3	
	ZO3C03PM25	Methods and Approaches in Physiology, Cytology, Biophysics and Biotechnology	10	4	
		TOTAL	15+10=25	19	
ELECTIVE BUNCH A - MOLECULAR BIOLOGY					
IV	ZO4E01TM25	Molecular Biology	5	4	23
	ZO4E02TM25	Molecular Immunology	5	4	
	ZO4E03TM25	Cancer Biology	5	4	
	ZO4E01PM25	Molecular Biology and Molecular Immunology	10	4	
		TOTAL	15+10=25	16	
	ZO4PRM25	Project/Dissertation		5	

	ZO4VM25	Viva Voce		2	
	TOTAL				80

ELECTIVE COURSES

Course code	Course Title	Teaching hours per week	Credit
ELECTIVE BUNCH A - MOLECULAR BIOLOGY			
ZO4E01TM25	Molecular Biology	5	4
ZO4E02TM25	Molecular Immunology	5	4
ZO4E03TM25	Cancer Biology	5	4
ZO4E01PM25	Molecular Biology and Molecular Immunology	10	4
ELECTIVE BUNCH B - ENVIRONMENTAL SCIENCE			
ZO4E04TM25	Environmental Science: Concepts and Approaches	5	4
ZO4E05TM25	Environmental Pollution and Toxicology	5	4
ZO4E06TM25	Environmental Management and Development	5	4
ZO4E02PM25	Environmental Science	10	4

ELECTIVE BUNCH C- FISHERY SCIENCE			
ZO4E07TM25	Ichthyology	5	4
ZO4E08TM25	Fishery Resources and Management	5	4
ZO4E09TM25	Fishery Technology	5	4
ZO4E03PM25	Fishery Biology	10	4

Distribution of credits:

The total credit for the programme is fixed at 80. The distribution of credit points in each semester and allocation of the number of credit for theory courses, project and viva is as follows. The credit of theory courses is 3 or 4 per course in the first, second and third semesters. The core courses in the fourth semester will have 4 credits and elective core courses will have 3 credits. The practical courses have a credit of 4. The project and viva voce will have a credit of 2 each.

The distribution of credit is shown below.

Semester	Courses	Credit	Total Credit
I	3 Theory Core Courses	4	$3 \times 4 = 12$
	1 Theory Core Course	3	$1 \times 3 = 3$
	1 Practical Core Course	4	$1 \times 4 = 4$
	3 Theory Core Courses	4	$3 \times 4 = 12$
	1 Theory Core Course	3	$1 \times 3 = 3$

II	1 Practical Core Course	4	$1 \times 4 = 4$
III	3 Theory Core Courses	4	$3 \times 4 = 12$
	1 Theory Core Course	3	$1 \times 3 = 3$
	1 Practical Core Course	4	$1 \times 4 = 4$
	3 Theory Elective Courses	4	$3 \times 4 = 12$
IV	1 Practical Elective Course	4	$1 \times 4 = 4$
	1 Project / Dissertation	5	$1 \times 5 = 5$
	1 Viva Voce	2	$1 \times 2 = 2$
	GRAND TOTAL		

EVALUATION AND GRADING

The evaluation for each course shall contain two parts such as In-Semester Assessment (ISA) and End Semester Assessment (ESA). The ratio between ISA and ESA shall be 1:3 and 25% weightage shall be given to ISA and 75% to ESA. Both ISA and ESA shall be carried out using direct grading system.

Evaluation (Both ISA and ESA) to be done by the teacher is based on a Six point scales shown in the table below:

GRADE	GRADE POINT	RANGE
A ⁺	5	4.50 to 5.00
A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

Direct Grading System based on a 7 – point scale is used to evaluate the performance of students in both ISA and ESA.

For all courses (theory & practical), semester/ overall programme, the letter grades for **GPA/SGPA/CGPA** and its indicators are given in the following table.

RANGE	GRADE	INDICATOR
4.50 to 5.00	A ⁺	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B ⁺	Very good
3.00 to 3.49	B	Good

2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal
0.00 to 1.99	D	Deficient (Fail)

IN-SEMESTER ASSESSMENT (ISA)

The In-Semester Assessment is to be done by continuous assessments of the components given below. The components of ISA for theory and practical and their weightage are as in the following tables.

THEORY	
COMPONENTS	WEIGHTAGE
Assignment	2
Seminar	4
Test Papers (Average of 2)	4
TOTAL	10

PRACTICALS	
COMPONENTS	WEIGHTAGE
Written/ Lab tests	3
Lab involvement and record	1
Viva	1
TOTAL	5

The two test papers in the Theory component should be in the same model as the ESA question paper. For test papers, questions shall be set in such a way that the answers can be awarded A⁺, A, B, C, D or E grade.

The performance of students in the seminar and assignment should also be documented in terms of grades.

The components for assignments and seminars are as in the following table:

ASSIGNMENT COMPONENTS	SEMINAR COMPONENTS
Punctuality	Content
Content	Presentation

The components of ISA for project and their weightage are as in the following table.

COMPONENTS	WEIGHTAGE
Relevance of the topic and analysis	2
Project content and presentation	2
Project viva	1
TOTAL	5

The ISA of the project is done by the supervising guide of the department or the member of the faculty decided by the head of the department. The project work may be started at the end of Semester II. The supervising guide should keenly and sincerely observe the performance of the student during the course of project work. The supervising guide is expected to inculcate in students, the research aptitude and aspiration to learn and aim high in the realm of research and development. A maximum of two students may be allowed to perform one project work if the volume of the work demands it. Project evaluation begins with (i) The selection of problem, (ii) Literature survey, (iii) Work plan, (iv) Experimental / theoretical setup/data collection, (v)

Characterization techniques/ computation/ analysis (vi) Use of modern software for data analysis/experiments and (vi) Preparation of project report. The project internal grades are to be submitted at the end of Semester IV.

The components of ISA for comprehensive viva voce and their weightage are as in the following table.

COMPONENTS	WEIGHTAGE
Fundamental concepts	3
Awareness of current /advanced topics	2
TOTAL	5

GENERAL INSTRUCTIONS FOR ISA

- The In-Semester assessment should be fair and transparent. The responsibility of evaluating the ISA is vested on the teacher(s) who teach the course. The evaluation of the components should be published and acknowledged by students.
- The assignments/ seminars / test papers are to be conducted at regular intervals. These should be marked and promptly returned to the students.
- One teacher appointed by the Head of the Department will act as a coordinator for consolidating grade sheet for ISA in the department in the format provided by the Controller of the examinations. The consolidated grade sheets are to be published in the department notice board, one week before the closing of the classes for ESA. The grade sheet should be signed by the coordinator and counter signed by the Head of the Department and the Principal.
- There shall be no separate minimum grade point for ISA of theory, practical, project and comprehensive viva voce. Though no separate minimum is required for internal evaluation for a pass, a minimum C grade is required for a pass in an external evaluation. And a minimum C grade is required for pass in a course.

- The consolidated grades in specific format are to be kept in the college for future references for 2 years. The consolidated grades in each course should be uploaded to the Institution Portal at the end of each semester as directed by the Controller of Examinations.
- There shall not be any chance for the improvement of ISA grade points.

Grievance Redressal Mechanism for ISA

There will be provision for grievance redressal at three levels, viz,

1. At the level of teacher concerned,
2. At the level of departmental committee consisting of Head of the Department, Coordinator and teacher concerned,
3. At the level of college committee consisting of the Principal, Controller of Examinations and Head of the Department.

END SEMESTER ASSESSMENT (ESA)

The End Semester Assessment of all semesters shall be conducted by the institution on the close of each semester. The End Semester Assessment will be of 3 hours duration for each lecture based and 4 hours duration for practical courses. A minimum C grade is required for a pass in ESA. Also in aggregate, a minimum C grade is required for a pass in a course.

Students with less than 73% aggregate attendance during a semester are not eligible to attend ESA of any course.

If a student represents her Institution/ University / State/ Nation in Sports /NCC/ NSS or Cultural or any other officially sponsored activities such as college union/university union etc, she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of 15 days in a semester based on the specific recommendations of the Head of the Department or teacher concerned.

For reappearance/ improvement, students may appear along with the next batch. However, the students who fail in Semester 3 will have the opportunity to appear for a special supplementary (SAVE AN YEAR-SAY) exam conducted at the end of Semester 3.

QUESTION PAPER PATTERN FOR THEORY COURSES

All the theory question papers are of three hour duration. All question papers will have three parts. The question shall be prepared in such a way that the answers can be awarded the grades A+, A, B, C, D or E.

The questions in each section will be grouped according to the Course Outcomes (COs), with the selection of questions to be answered falling under a single CO. Thus, the mandatory attempt of all COs can be ensured for the calculation of course outcome attainment.

Part A: Questions in Part A are very short answer type. A total of eight questions need to be answered, each carrying a weightage of 1, contributing to a cumulative weightage of 8 for the section.

For courses with 4 COs, there will be 4 bunches of 3 questions each, assigned to each CO, and students must answer 2 questions from each bunch.

For courses with 5 COs, there will be 2 bunches of 2 questions each, assigned to the COs assessed in Part C, from which 1 question must be answered. Additionally, 3 bunches containing 3 questions each will be allotted to the remaining COs, from which 2 questions must be answered

Part B: Part B consists of problem solving and short essay type questions related to the course. A total of six questions need to be answered, each carrying a weightage of 2, contributing to a cumulative weightage of 12 for the section.

For courses with 4 COs, there will be 2 bunches of 4 questions each, assigned to those COs not assessed in Part C, and students must answer 3 questions from each bunch.

For courses with 5 COs, there will be 3 bunches of 3 questions each, assigned to the COs not assessed in Part C, from which students must answer 2 questions from each bunch.

Part C: Part C will have four questions, grouped into two bunches, with each bunch containing two questions related to the same CO. Students must answer one question from each set. Each question will carry a weightage of 5, contributing to a total weightage of 10 for Part C.

Maximum weightage for End-Semester Assessment is 30. Therefore, Maximum Weighted Grade Point (WGP) is 150.

DIRECTIONS FOR QUESTION SETTERS:

- 1) Questions shall be set to assess knowledge acquired, standard and application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge.
- 2) Due weightage shall be given to each module on content/teaching hours allotted to each module.
- 3) The question setter shall ensure that questions are set as per the course outcomes.
- 4) A question paper shall be a judicious mix of short answer type, short essay type/problem solving type and long essay type questions.
- 5) The questions shall be set in such a way that the answers can be awarded A⁺, A, B, C, D or E grade.
- 6) Different types of questions shall be given different weightage to quantify their range as shown below:

Sections	Type of Questions	Weightage	No. of COs	Number of questions to be answered (CO*- COs assessed in Part C)
Part A	Short Answer type	1	4	2 out of 3 from each CO bunch
			5	1 out of 2 from each CO* bunch 2 out of 3 from each CO bunch
Part B	Short essay/ problem solving type	2	4	3 out of 4 from each CO bunch
			5	2 out of 3 from each CO bunch
Part C	Long Essay type	5	4	1 out of 2 from each CO* bunch
			5	

BLUEPRINT (For Courses with 4 COs or 72 hours)

CO	Part A Weight 1 each (Total weights=8)	Part B Weight 2 each (Total weights =12)	Part C Weight 5 each (Total weights = 10)	Total Weights (30 out of 48)
	Part Ai (2 out of 3 questions of each CO)	Part Bi (3 out of 4 questions of a given CO)	Part Ci (1 out of 2 questions of a given CO)	
CO1	3	0/0/0/4/4/4	2/2/2/0/0/0	13/13/13/11/11/11
CO2	3	0/4/4/0/0/4	2/0/0/2/2/0	13/11/11/13/13/11
CO3	3	4/0/4/0/4/0	0/2/0/2/0/2	11/13/11/13/11/13
CO4	3	4/4/0/4/0/0	0/0/2/0/2/2	11/11/13/11/13/13

- Part A will contain section Ai (A1 to A4)
Part B will contain Bi sections (B1-B2)
Part C will contain Ci sections (C1 to C2)
- COs assessed in Part C (Essay) will not appear in Part B section.
- The blue print models are numbered as 4BP₁ to 4BP₆ denoted by each slash in the table

BLUEPRINT (For Courses with 5 COs or 90 hours)

CO	Part A Weight 1 each (Total weights=8)		Part B Weight 2 each (Total weights =12)	Part C Weight 5 each (Total weights = 10)	Total Weights (30 out of 51)
	Part Ai * [1 out of 2 questions of each CO*]	Part Ai [2 out of 3 questions of each CO]	Part Bi [2 out of 3 questions of a given CO]	Part Ci [1 out of 2 questions of a given CO*]	
CO1	2/2/2/2/0/0/0 /0/0/0	0/0/0/0/3/3/3/ 3/3/3	0/0/0/0/3/3/3/3 /3/3	2/2/2/2/0/0/0/0 /0/0	12/12/12/12/ 9/9/9/9/9/9
CO2	2/0/0/0/2/2/2 /0/0/0	0/3/3/3/0/0/0/ 3/3/3	0/3/3/3/0/0/0/3 /3/3	2/0/0/0/2/2/2/0 /0/0	12/9/9/9/12/1 2/12/9/9/9
CO3	0/2/0/0/2/0/0 /2/2/0	3/0/3/3/0/3/3/ 0/0/3	3/0/3/3/0/3/3/0 /0/3	0/2/0/0/2/0/0/2 /2/0	9/12/9/9/12/9 /9/12/12/9
CO4	0/0/2/0/0/2/0 /2/0/2	3/3/0/3/3/0/3/ 0/3/0	3/3/0/3/3/0/3/0 /3/0	0/0/2/0/0/2/0/2 /0/2	9/9/12/9/9/12 /9/12/9/12
CO5	0/0/0/2/0/0/2 /0/2/2	3/3/3/0/3/3/0/ 3/0/0	3/3/3/0/3/3/0/3 /0/0	0/0/0/2/0/0/2/0 /2/2	9/9/9/12/9/9/ 12/9/12/12

- Part A will contain Ai sections (A1 to A5)
Part B will contain Bi sections (B1-B3)
Part C will contain Ci sections (C1 to C2)
- Asterisk * denotes the COs which are assessed in Part C section as Essay questions. CO* will be absent in Part B section. Only 2 questions of CO* each will be given in Part A section.
- While COs which are not assessed in Part C section will be allotted 3 questions each in Part A and Part B sections.
- The blue print models are numbered as 5BP₁ to 5BP₁₀ denoted by each slash in the table.

PRACTICAL, PROJECT AND VIVA VOCE EXAMINATIONS

PRACTICAL EXAMINATION

The practical examinations will be conducted at the respective examination centres by one external and one internal examiner appointed by the controller of examinations at the end of each semester.

There will be four practical examination boards every year to conduct these practical exams. All practical examinations will be of 4 hours duration.

One external examiner will be selected from the panel of examiners and one internal examiner will be selected by the department.

EVALUATION OF PRACTICAL EXAMINATIONS:

The scheme of evaluation of the practical examination will be decided by the board of examiners. The different weights for assessment of different components is shown in the following table:

COMPONENTS	WEIGHTAGE
Written/Lab test	10
Record	3
Viva	2
Total	15

PROJECT EVALUATION

The project is evaluated by one external and one internal examiner. The project is examined along with the oral presentation of the project by the candidate. The examiners should ascertain that the project and report are genuine. Innovative projects or the results/ findings of the project presented in national seminars may be given maximum advantage. The supervising guide or the faculty appointed by the head of the department may be allowed to be present at the time of

project evaluation. This is only to facilitate proper evaluation of the project. The different weightage for assessment of different components is shown in the following table.

COMPONENTS	WEIGHTAGE
Relevance of the topic and analysis	2
Project content and presentation	10
Project viva	3
TOTAL	15

COMPREHENSIVE VIVA- VOCE EXAMINATION

Viva-voce shall be conducted by one external examiner and one internal examiner of the board of examiners. The viva-voce shall cover questions from all courses in the programme.

The components of the ESA for comprehensive viva-voce and their weightage are as in the following table.

COMPONENTS	WEIGHTAGE
Fundamental concepts	9
Awareness of current topic/advanced topic	6
TOTAL	15

Both project evaluation and viva voce are to be conducted in batches of students formed for practical examinations.

REAPPEARANCE / IMPROVEMENT

- A student who fails to secure a minimum grade (Grade C) for a pass in a course will be permitted to write the examination along with the next batch.

- The candidate who wishes to improve the grade/grade point of the End-Semester Assessment of a course / course she has passed can do the same by appearing in the End-Semester Assessment of the semester concerned along with the immediate junior batch. This facility is restricted to first and second semesters of the programme.
- There shall be supplementary examinations (no improvement) for third semester.

PROMOTION

- A student who registers for a particular semester examination shall be promoted to the next semester.
- A student having 73% attendance and fails to register for examination of a particular semester will be allowed to register notionally and is promoted to the next semester, provided application for notional registration shall be submitted within 15 days of the commencement of the next semester.

COMPUTATION OF GPA/SGPA/CGPA

Grade Point Average (GPA): ISA and ESA are separately graded using a six point scale and the combined grade point with weightage 1 for ISA and 3 for ESA shall be applied to calculate the grade point average (GPA) of each course.

The Semester Grade Point Average (SGPA): After the successful completion of a semester SGPA of a student in that semester is calculated using the formula given below.

Semester Grade Point Average (SGPA) = $\frac{\sum(C_i \times GPA_i)}{\sum C_i}$ where C_i and GPA_i are the credit point and GPA of each course respectively.

Cumulative Grade Point Average (CGPA) for the programme is calculated as follows:

CGPA = $\frac{\sum(C_i \times SGPA_i)}{\sum C_i}$ where C_i and $SGPA_i$ are the total credit point and SGPA of each semester respectively.

Note: A separate minimum of **C** Grade for ESA (for both theory and practical) is required for pass for a course. For a pass in a programme, a separate minimum of Grade **C** is required for all the individual courses. If a candidate secures **D** Grade for any one of the courses offered in a Semester/Programme, only **D** grade will be awarded for that Semester/Programme until she improves this to **C** grade or above within the permitted period.

Note: On compliance with the UGC minimum standards for the conduct and award of postgraduate degrees: Credit and semester system is followed in this program. The program has 4 semesters with eighteen weeks in each semester. In each semester there are 450 hours including both lecture and practical hours which is in compliance with the minimum 390 hours stipulated by the UGC.

All Rules and regulations are subject to change as and when modified by MG University to which St Teresa's College (Autonomous) is affiliated.

SYLLABI FOR CORE COURSES OF

M. Sc. ZOOLOGY

SEMESTER I

SEMESTER I
CORE COURSE

**ZO1C01TM25 - ANIMAL DIVERSITY: PHYLOGENETIC AND
TAXONOMIC APPROACHES**

Credits: 4

Total Lecture Hours: 72

Course Outcomes:

CO1: Explain the process of invertebrate evolution. (Understand)

CO2: Summarize the basic concept of progressive evolutionary and phylogenetic adaptation of various classes of vertebrates. (Understand)

CO3: Explain basics and procedures of classification and the use of different taxonomic keys and publications. (Understand)

CO4: Express the theoretical and practical knowledge in taxonomic arrangement for accurate classification. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	1	2

Syllabus Content

PHYLOGENETIC APPROACHES (36 hrs)

Module I (CO1) (18 hrs)

Origin of Animals

Progenote, Prokaryotes and Eukaryotes. Extant and ancient stromatolites. Unicellularity to metazoans – consequences and complexity. Multicellular organisms – Ediacaran fauna, Burgess Shale Fauna. Cambrian explosion, Cropping and Red Queen Principle. Different hypothesis of metazoan origin – Gastraea hypothesis, Planula hypothesis.

Invertebrate Phylogeny

Evolutionary advantages of Symmetry, Coelom and Metamerism. Phylogenetic relationships among Porifera, Placozoa, Mesozoans, Cnidaria and Ctenophore; Platyhelminthes and other acoelomates. Phylogenetic relationships among the protostome lineage – Mollusca, Annelida and Arthropod. Adaptive radiation in Mollusca, Annelida, Arthropod and Echinoderms. Position and phylogeny of Hemichordates. Affinity with invertebrates and protochordate.

Module II (CO 2)

(18 hrs)

Vertebrate Phylogeny

Paedomorphosis in vertebrate phylogeny. Jawless vertebrates – Ostracoderms and Cyclostomes. Properties and advantages of bone in vertebrate evolution. Evolution of jawed vertebrates – Acanthodian, Placoderm, Chondrichthyes, Osteichthyes. Actinopterygians and Sarcopterygians.

Phylogeny of Herpeto fauna

Amphibian phylogeny – Osteolepiforms, stem tetrapods and early amphibians. Lissamphibians – distribution, diversity, status and threats. Reptilian phylogeny – amniotic egg, distinguishing features between amniotes from extant amphibians. Adaptive radiation in reptiles. Importance of skull in reptilian classification. Endothermy in Dinosaurs. Causes of extinction.

Phylogeny of Birds and Mammals

Evidences for the origin of birds from reptiles. Classification of mammals. Mammalian phylogeny and therapsids – significance of teeth, jaws and hearing. Adaptive radiation in mammals. Phylogeny of mammalian orders. Rare, endangered and endemic birds and mammals of Indian subcontinent.

TAXONOMIC APPROACHES

(36 hrs)

Module III (CO 3)

(18 hrs)

Biological Classification

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation, curating and process of identification (Brief and general account only). Taxonomic characters of different kinds and analysis of variation. Zoological types – Principles of typification. International code of Zoological Nomenclature – features, principles and rules. Phylocode. ZooBank.

Taxonomic Keys and Publications

Different types of keys – single access keys, diagnostic and synoptic keys, dichotomous and polytomous keys, Computer aided keys. Merits and demerits of keys. Types of taxonomic publications – atlas, catalogue, checklist, field guide, field book, hand book, manual, monographs. Zoological records. Ethics in taxonomy.

Module IV (CO 4)

(18 hrs)

Trends in Taxonomy

Modern methods – Morphological, cytological, biochemical, numerical and molecular. Molecular Phylogeny in Systematics and its importance. Use of protein and nucleotide sequence in molecular phylogeny. Protein sequence – haemoglobin and cytochrome. Nucleic acid phylogeny. Importance of molecular phylogeny Cladistic analysis – Apomorphy, Plesiomorphy, Sympleiomorphy and Synapomorphy. Characteristic features of cladistics. Methodology of cladistics analysis – construction of cladogram. Significance of phylogenetic systematics. Phylogenetic trees. Different kinds – cladogram, phenogram, phylogram, dendrogram, curvogram, eurogram, swoopogram, chronogram. Molecular Taxonomy: DNA barcoding, Phylogenetic studies based on molecular data (nuclear, mitochondrial, and chloroplast DNA). Introduction to Integrative Taxonomy, Digital Taxonomy, Automated and AI-Assisted Taxonomy (Brief account only).

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MODEL QUESTION PAPER

(As per blueprint model 4BP1)

M. Sc. Degree (CSS) Examination Semester I

**ZO1C01TM25 - ANIMAL DIVERSITY: PHYLOGENETIC AND TAXONOMIC
APPROACHES**

Time: 3 Hours

Maximum Weightage: 30

Part A

Part A1. Answer any 2 questions from the bunch for CO1. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
1.	Distinguish between Prokaryotes and Eukaryotes.	CO1	U
2.	Summarize on Burgess shale fauna.	CO1	U
3.	State the significance of stromatolites in deducing ancient life.	CO1	R

(2x 1= 2 weights)

Part A2. Answer any 2 questions from the bunch for CO2. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
4.	Explain paedomorphosis in vertebrate phylogeny.	CO2	U
5.	Discuss the distribution, diversity, status and threats of lissamphibians.	CO2	U
6.	Explain the importance of skull in reptilian classification.	CO2	U

(2x 1= 2 weights)

Part A3. Answer any 2 questions from the bunch for CO3. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
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7.	Explain the hierarchy of categories.	CO3	U
8.	Define phylocode.	CO3	R
9.	Differentiate between catalogue and monographs.	CO3	U

(2x 1= 2 weights)

Part A4. Answer any 2 questions from the bunch for CO 4. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
10.	Explain the significance of phylogenetic systematics.	CO4	U
11.	Differentiate between curvogram and eurogram.	CO4	U
12.	Describe briefly about AI-Assisted Taxonomy.	CO4	U

(2x 1= 2 weights)

Part B

Part B1. Answer any 3 questions from the bunch for CO3. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
13.	Explain the different taxonomic procedures.	CO3	U
14.	Describe about different types of keys.	CO3	U
15.	Summarize the different types of taxonomic publications.	CO3	U
16.	Explain the features, principles and rules of international code of Zoological Nomenclature.	CO3	U

(3x 2= 6 weights)

Part B2. Answer any 3 questions from the bunch for CO4. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
17.	Explain molecular phylogeny in systematics and its importance.	CO4	U
18.	Describe the steps involved in construction of cladogram	CO4	U
19.	Summarize about different types of phylogenetic trees.	CO4	U
20.	Discuss the characteristic features and methodology of cladistic analysis.	CO4	U

(3x 2= 6 weights)

Part C

Part C1. Answer any 1 question from the bunch for CO1. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
21.	Classify the major classes under Arthropods and comment on its phylogeny.	CO1	U
22.	Explain the different classes under Mollusca. Give details on Molluscan adaptive radiation.	CO1	U

(1x 5= 5 weights)

Part C2. Answer any 1 question from the bunch for CO2. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
23.	Explain about the evolution of jawed vertebrates.	CO2	U
24.	Distinguish the features between amniotes from extant amphibians. Add a note on adaptive radiation in reptiles.	CO2	U

(1x 5= 5 weights)

Blueprint model 4BP₁ for 4 COs

Module	CO	Part	Part	Part	Part	Part	Part	Part	Part	Total Weights (30 out of 48)
		A1	A2	A3	A4	B1	B2	C1	C2	
		Any 2 out of 3 questions of				Any 3 out of 4 questions of		Any 1 out of 2 questions of		
		CO1	CO2	CO3	CO4	CO3	CO4	CO1	CO2	
Module I (18 hrs)	CO1	3	0	0	0	0	0	2	0	13
Module II (18 hrs)	CO2	0	3	0	0	0	0	2	0	13
Module III (18 hrs)	CO3	0	0	3	0	4	0	0	0	11
Module IV (18 hrs)	CO4	0	0	0	3	0	4	0	0	11

* End Semester evaluation of the course will be done using any of the blueprint model for 4 COs (4BP₁ to 4BP₆)

SEMESTER I
CORE COURSE

ZO1C02TM25 - EVOLUTIONARY BIOLOGY AND ETHOLOGY

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Explain origin of life, theories of evolution, concepts of biochemical and molecular evolution. (Understand)

CO2: Explain population and evolutionary genetics to analyze the major evolutionary events. (Understand)

CO3: Describe the key behavioral terms, biological influences on behavior, models of motivation, and learning processes. (Understand)

CO4: Explain reproductive and social behaviors, biological rhythms and stress responses in animals. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	1	2

Syllabus Content

EVOLUTIONARY BIOLOGY (36 hrs)

Module I (CO 1) (18 hrs)

Origin and Evolution of Life

Concepts of variation, adaptation, struggle, fitness and natural selection-spontaneity of mutation and the evolutionary synthesis. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium). The RNA world, The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes. Anaerobic

metabolism - origin of photosynthesis and aerobic metabolism.

Molecular Evolution

Rose Mary and Peter Grant (Molecular evolution in Darwinian finches). Neutral theory of molecular evolution; molecular divergence; molecular drive. Molecular clocks- genetic equidistance. Phylogenetic relationships- Homology; Homologous sequences of proteins and DNA - orthologous and paralogous, parsimony analysis; nucleotide and protein sequence analysis.

Module II (CO 2)

(18 hrs)

Population Genetics

Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift, Founder effect and Bottle neck phenomenon, Isolation and speciation, Co-evolution.

Developmental and Evolutionary Genetics

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

Geological Timescale

Major events in evolutionary timescale. Mass extinction and its consequences. Fossils – fossilization and its significance.

Primate Evolution and Human Origins

Stages in Primate evolution- Prosimii, Anthropeida and Hominids. Factors in human origin hominid fossils. Cytogenetic and molecular basis of origin of man - African origin of modern man - Mitochondrial Eve, Y chromosomal Adam. Evolution of culture.

ETHOLOGY

(36 hrs)

Module III (CO 3)

(18 hrs)

Introduction and Biological Basis of Behaviour

Definition, historical out line. Terminologies: Sign stimuli, key stimuli, social releasers, displacement activities, Ritualization, Ethograms, super normal stimuli, stimulus filtering, open and closed IRM, mimetic releaser, code breakers. JP Scott's categories of behaviour.

Behaviour - Genetic and neurological basis of behavior, Hormones and behavior. Reflex action, Sherrington's neuro-physiological concepts in behaviour. Fixed action patterns. Goal oriented

drive, Psycho- hydrologic model of motivation. Studies of motivation in guppies. Learning - Short and long term memory, Habituation, Sensitization. Conditioning, Reasoning. Communication - Evolution of communication, Sensory mechanisms: electrical, chemical, olfactory, auditory and visual. Dance language of honey bees, Pheromonal communication (Ants and mammals).

Module IV (CO 4)

(18 hrs)

Reproductive and other types of behaviour

Reproductive strategies, Mating systems, Courtship, Sexual selection- intrasexual and intersexual, good gene hypothesis, parental care and investment – significance of prolactin.

Complex behaviour/ Biological rhythm -Orientation, Navigation, Migration (fishes and birds), Navigation cues. Biological rhythms, circadian, circannual, lunar periodicity, tidal rhythms. Genetics of biological rhythms. Social Behaviour - Sociobiology (Brief account only), social organization in insects and primates. Aggregations – schooling in fishes, herding in mammals, group selection, kin selection, altruism (alarm call as an example), reciprocal altruism, inclusive fitness, Hamilton's rule, co-operation. Foraging behaviour: Habitat selection and optimality in foraging; social foraging, territoriality.

Stress and Behaviour - Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance. Stress and animal welfare.

References

EVOLUTIONARY BIOLOGY

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15. **Web Resource:**
<http://www.academicearth.org> <http://www.talkorigins.org> <http://www.ucmp.berkeley.edu>

ETHOLOGY

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2. Breed, M. D., & Moore, J. (2015). *Animal behavior*. Academic Press.
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10. Manning, A., & Dawkins, M. S. (1998). *An introduction to animal behaviour*. Cambridge University Press.

11. Scott, G. (2009). *Essential animal behavior*. John Wiley & Sons.
12. Wilson, E. O. (2000). *Sociobiology: The new synthesis*. Harvard University Press.
13. **Web Resource:**
www.animalbehavioronline.com/modestable.html

MODEL QUESTION PAPER

(As per blueprint model 4BP₂)

M. Sc. Degree (CSS) Examination Semester I

ZO1C02TM25 - EVOLUTIONARY BIOLOGY AND ETHOLOGY

Time: 3 Hours

Maximum Weightage: 30

Part A

Part A1. Answer any 2 questions from the bunch for CO1. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
1.	Define the RNA world.	CO1	R
2.	Explain endosymbiotic theory.	CO1	U
3.	Discuss about punctuated equilibrium.	CO1	U

(2x 1= 2 weights)

Part A2. Answer any 2 questions from the bunch for CO2. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
4.	Define heterochrony.	CO2	R
5.	Distinguish between gene pool and gene frequency.	CO2	U
6.	Describe Y chromosomal Adam.	CO2	U

(2x 1= 2 weights)

Part A3. Answer any 2 questions from the bunch for CO3. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
7.	Explain key stimuli.	CO3	U
8.	Differentiate between open and closed IRM.	CO3	U

9.	Discuss the relevance of mimetic releaser.	CO3	U
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(2x 1= 2 weights)

Part A4. Answer any 2 questions from the bunch for CO 4. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
10.	Differentiate between group selection and kin selection.	CO4	U
11.	Write a note on inclusive fitness.	CO4	U
12.	Discuss on monogamy.	CO4	U

(2x 1= 2 weights)

Part B

Part B1. Answer any 3 questions from the bunch for CO3. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
13.	Describe the factors affecting Hardy-Weinberg equilibrium.	CO2	U
14.	Explain the idea of co-evolution.	CO2	U
15.	Give examples of mass extinction and mention its consequences.	CO2	U
16.	Explain the evolution of culture.	CO2	U

(3x 2= 6 weights)

Part B2. Answer any 3 questions from the bunch for CO4. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
17.	Describe the significance of alarm calls in social behaviour. Cite one example.	CO4	U

18.	Summarize the major events of schooling in fishes and herding in mammals.	CO4	U
19.	Discuss the idea of animal stress and its adaptations.	CO4	U
20.	Describe the different types of orientation.	CO4	U

(3x 2= 6 weights)

Part C

Part C1. Answer any 1 question from the bunch for CO1. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
21.	Discuss the evolution of prokaryotes to unicellular eukaryotes.	CO1	U
22.	Discuss Darwinism in the light of modern developments in biology.	CO1	U

(1x 5= 5 weights)

Part C2. Answer any 1 question from the bunch for CO2. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
23.	Explain pheromonal communication with special reference to communication in ants and mammals.	CO3	U
24.	Elaborate on types and significance of learning in animal behaviour.	CO3	U

(1x 5= 5 weights)

Blueprint model 4BP₂ for 4 COs

Module	CO	Part A1	Part A2	Part A3	Part A4	Part B1	Part B2	Part C1	Part C2	Total Weights (30 out of 48)
		Any 2 out of 3 questions of				Any 3 out of 4 questions of		Any 1 out of 2 questions of		
		CO1	CO2	CO3	CO4	CO3	CO4	CO1	CO2	
Module I (18 hrs)	CO1	3	0	0	0	0	0	2	0	13
Module II (18 hrs)	CO2	0	3	0	0	4	0	0	0	11
Module III (18 hrs)	CO3	0	0	3	0	0	0	0	2	13
Module IV (18 hrs)	CO4	0	0	0	3	0	4	0	0	11

* End Semester evaluation of the course will be done using any of the blueprint model for 4 COs (4BP₁ to 4BP₆)

SEMESTER I
CORE COURSE

ZO1C03TM25 - BIOCHEMISTRY

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Explain the structure, classification, metabolism and inborn errors in carbohydrates.
(Understand)

CO2: Explain the structure, classification, metabolism and inborn errors in Protein. (Understand)

CO3: Explain the structure, classification, metabolism and inborn errors in Lipids and Nucleic acids. (Understand)

CO4: Discuss the mechanism kinetics, regulation and clinical significance of enzymes.
(Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	2
CO2	2	2	3	1	2
CO3	2	2	3	1	2
CO4	2	2	3	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Carbohydrates

Classification, Structure, nomenclature and Biological functions of carbohydrates.

Monosaccharides; Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Glycosidic bond. Disaccharides: Sucrose, Lactose, Maltose and Cellobiose. Polysaccharides: Homopolysaccharides – Starch, Glycogen, Cellulose, Chitin, Dextran, Inulin, Pectin. Heteropolysaccharides – Hyaluronic acid, Heparin, Chondroitin

sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Carbohydrate Metabolism

Major metabolic pathways- Glycolysis, Citric acid cycle and its significance. Oxidative and substrate level phosphorylation. Gluconeogenesis, Cori cycle. Glycogen metabolism- Glycogenesis, Glycogenolysis, Regulation of carbohydrate metabolism, Role of insulin and glucagon. Adenylate cascade system, Ca²⁺ Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis. Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Galactose metabolism.

Disorders of Carbohydrate Metabolism

Diabetes mellitus, glucose and galactose tolerance tests, sugar levels in blood, renal threshold for glucose, factors influencing blood glucose level, Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria, pentosuria, galactosemia (Brief account only).

Module II (CO 2)

(18 hrs)

Proteins

Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pH, Buffer, pK value and iso-electric point of amino acids. Classification, properties and biological functions of proteins. Primary structure of protein (e.g. insulin). Conformation of proteins- chemical bonds that stabilise higher order structures. Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (brief account on any two: Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure- e.g. Myoglobin. Quaternary structure – e.g. Haemoglobin.

Metabolism of Proteins

Amino acid metabolism-Deamination, Transamination and Trans-deamination. Formation and disposal of ammonia. Urea cycle. 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.

Inborn Errors of Metabolism

Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia (Brief account only).

Module III: Lipids and Nucleic acids (CO 3)

(18 hrs)

Lipid structure and classification

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

Fatty acids: classification, Geneva system of nomenclature. Simple fats: Triacylglycerol (Triglycerides):- fats, oils and waxes. Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert- Meissl number of lipids. Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmalogens. Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids- cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins. Prostaglandins- structure, types and functions.

Metabolism of Lipids

Beta oxidation, alpha oxidation and omega oxidation of fatty acids. De novo synthesis of fatty acids. Lipid peroxidation. Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Preventive antioxidants and chain breaking antioxidants.

Disorders of Lipid metabolism

Plasma lipoproteins, cholesterol metabolism and its clinical significance, triglycerides & phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Gaucher's disease, Tay- Sach's and Niemann-Pick disease, ketone bodies – Metabolism and clinical significance, Abetalipoproteinemia (Brief account only).

Nucleic Acids structure and metabolism

Structure of nucleic acids, Structural organization of DNA (Watson-Crick model) Characteristic features of A, B, C and Z DNA. Metabolism - Catabolism of purines and pyrimidines.

Module IV (CO 4)

(18 hrs)

Enzymes

Enzymes: Classification- (I.U.B. system), co-enzymes, ribozyme. Enzyme specificity. Mode of enzyme action: Concept of Active site, Formation of enzyme substrate complex, Lowering of activation energy. Lock and key theory, induced fit theory, transition state and strain theory.

Enzyme kinetics

Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition, feedback inhibition- sequential, concerted and cumulative feedback control. Control of enzyme activity - control of activity by changes in covalent structures of enzymes, control of activity by ligand induced conformational changes in enzymes. Enzyme regulation: Allosteric regulations- Monod-Wyman-Changuex model, Koshland-Nemethy-Filmer model, Key enzymes, Flux analysis. Iso-enzymes and clinical significance.

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7th. W.H. Freeman & Co, UK.

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11. Oser, B.L.(1965). *Hawk's Physiological Biochemistry*. McGraw Hill Book Co. New Delhi.
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MODEL QUESTION PAPER

(As per blueprint model 4BP3)

M. Sc. Degree (CSS) Examination Semester I

ZO1C03TM25 – BIOCHEMISTRY

Time: 3 Hours

Maximum Weightage: 30

Part A

Part A1. Answer any 2 questions from the bunch for CO1. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
1.	Explain mutarotation of monosaccharides.	CO1	U
2.	Describe any two types of inborn errors associated with carbohydrate metabolism.	CO1	U
3.	Summarize the Cori cycle.	CO1	U

(2x 1= 2 weights)

Part A2. Answer any 2 questions from the bunch for CO2. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
4.	Explain the isoelectric point of amino acids?	CO2	U
5.	Illustrate Urea cycle.	CO2	U
6.	Summarize on chaperons with examples?	CO2	U

(2x 1= 2 weights)

Part A3. Answer any 2 questions from the bunch for CO3. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
7.	Describe Polenske number.	CO3	U

8.	Describe the key functions of nucleic acid and nucleotides.	CO3	U
9.	Classify antioxidants and cite examples.	CO3	U

(2x 1= 2 weights)

Part A4. Answer any 2 questions from the bunch for CO 4. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
10.	Explain Ribozymes.	CO4	U
11.	Describe on co-enzymes.	CO4	U
12.	Explain enzyme catalysed reactions based on thermodynamic/energy considerations.	CO4	U

(2x 1= 2 weights)

Part B

Part B1. Answer any 3 questions from the bunch for CO3. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
13.	Explain the primary structure of protein with examples.	CO2	U
14.	Discuss on the metabolism of amino acids.	CO2	U
15.	Describe the Ramachandran map. Add a note on its significance.	CO2	U
16.	Summarize the fate of the carbon skeleton of amino acids.	CO2	U

(3x 2= 6 weights)

Part B2. Answer any 3 questions from the bunch for CO4. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
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17.	Differentiate on any four biologically important steroids.	CO3	U
18.	Explain on Beta oxidation of fatty acids.	CO3	U
19.	Summarize the catabolism of purine nucleotides.	CO3	U
20.	Explain the properties of triacylglycerols.	CO3	U

(3x 2= 6 weights)

Part C

Part C1. Answer any 1 question from the bunch for CO1. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
21.	Explain Embden-Meyerhof pathway. Give details on its regulation. Predict the energetics of the pathway.	CO1	U
22.	Describe the Citric acid cycle and add a note on its regulation.	CO1	U

(1x 5= 5 weights)

Part C2. Answer any 1 question from the bunch for CO2. Each question carries 5 weights

Q. No	Questions (CO4)	CO	Level of Question
23.	Write a brief account on enzyme inhibition. Discuss the kinetics of enzyme inhibition.	CO4	U
24.	Discuss how enzyme regulation is brought about in living organisms. Comment on the different models of allosteric regulations.	CO4	U

(1x 5= 5 weights)

Blueprint model 4BP₃ for 4 COs

Module	CO	Part	Part	Part	Part	Part	Part	Part	Part	Total Weights (30 out of 48)
		A1	A2	A3	A4	B1	B2	C1	C2	
		Any 2 out of 3 questions of				Any 3 out of 4 questions of		Any 1 out of 2 questions of		
		CO1	CO2	CO3	CO4	CO3	CO4	CO1	CO2	
Module I (18 hrs)	CO1	3	0	0	0	0	0	2	0	13
Module II (18 hrs)	CO2	0	3	0	0	4	0	0	0	11
Module III (18 hrs)	CO3	0	0	3	0	0	4	0	0	11
Module IV (18 hrs)	CO4	0	0	0	3	0	0	0	2	13

* End Semester evaluation of the course will be done using any of the blueprint model for 4 COs (4BP₁ to 4BP₆)

SEMESTER I
CORE COURSE

ZO1C04TM25 - BIOSTATISTICS AND RESEARCH METHODOLOGY

Total Credits: 3

Total Lecture Hours: 54

Course Outcome

CO1: Apply the fundamentals of biostatistics- dispersion, correlation and regression. (Apply)

CO2: Explain probability methods, statistical tests and mathematical biology models in data interpretation. (Understand)

CO3: Describe research concepts, formulations and designs. (Understand)

CO4: Explain scientific documentation and communication through online and other resources. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	3	3
CO2	3	2	2	2	2
CO3	2	2	2	2	2
CO4	2	2	2	2	2

Syllabus Content

BIOSTATISTICS (27 hrs)

Module 1 (CO 1) (13.5 hrs)

Basics of Biostatistics

Scope and Significance of Biostatistics. Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources).

Measures of Central Tendency – mean, median and mode.

Measures of Dispersion

Introduction, Characteristics. Quartiles and Percentiles. Merits and Demerits of Range,

Quartile Deviation, Mean Deviation and Standard Deviation. Relative Measures of Dispersion. Calculations/Problems for frequency table. Standard error. Skewness and Kurtosis (Brief account only).

Correlation Analysis

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

Regression Analysis

Regression and Line of Best Fit, Types and methods of regression analysis.

Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of straight line through regression equation). Comparing correlation and regression.

Probit Analysis (Brief account only).

Module II (CO 2)

(13.5 hrs)

Theory of Probability

Measures of Probability and Theorems in Probability. Probability distributions – Binomial, Poisson and Normal (Brief Account only).

Parametric and Non-Parametric Test

Basic idea – Hypothesis testing, types of errors. Tests of significance for large and small samples - Z-test, Chi-Square Test, Student's 't' test, F-test – Problems. ANOVA. Characteristics, advantages, and disadvantages. Types of non-parametric tests (brief account only) Examples: Sign tests, Kruskal Wallis tests, Mann-Whitney U test, Spearman's rank correlation test.

Mathematical modeling in Biology

Introduction to mathematical modeling. Applications: Medicine - models to predict spread of infectious diseases, drug discovery, Systems Biology – Blue Brain project, Ecology – Lotka Volterra model. Length - Weight Relationship. Von- Bertalanffy's Growth (VBG) Model. Statistical Software: MS Excel, SPSS; Introduction to 'R' (Basics only).

RESEARCH METHODOLOGY

(27 hrs)

Module III (CO 3)

(13.5 hrs)

Concepts of Research

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 Process.

Research Formulation

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 review in defining a problem, Critical literature review. Theory, Principle, Law and Canon.

Research Designs

Research Design -Basic principles, Meaning, Need and features of good design. Types of research designs.

Development of a research plan - Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs. Case-control studies and cohort studies.

Module IV (CO 4)

(13.5 hrs)

Scientific Documentation and Communication

Structure and components of Scientific Reports – types of Report – Technical Reports and Thesis/dissertations. Preparing Research papers for journals, Seminars and Conference; Impact factor, Citation Index, h-index. DOI. ISBN & ISSN. Conventions and strategies of authentication – citation styles, bibliography, referencing and foot notes. Software for managing bibliographies - EndNote. Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference, Oral presentation, Poster Presentation. Preparation of Project Proposal. Project funding agencies – UGC, DST, BDT, MoEF. Women Scientists schemes. Global Information System – BIOSIS, Medline and Medlars, AGRIS, Pubmed, Google Scholar.

Information Science, Extension and Ethics

Sources of Information - Primary and secondary sources.

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

Online resources – INFLIBNET, e-libraries, e-Books, e-Encyclopedia, e-Journals, e-Thesis, Shodhganga, PG - Pathshala, TED Talk, Institutional Websites. MOOC - SWAYAM, NPTEL. Networking platforms for researchers - Academia, ResearchGate.

Ethics in research - Plagiarism, Plagiarism checking softwares - Turnitin, Viper, Urkund;
Citation and Acknowledgement.

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

References

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MODEL QUESTION PAPER

(As per blueprint model 4BP4)

M. Sc. Degree (CSS) Examination Semester I

ZO1C04TM25 - BIOSTATISTICS AND RESEARCH METHODOLOGY

Time: 3 Hours

Maximum Weightage: 30

Part A

Part A1. Answer any 2 questions from the bunch for CO1. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
1.	Distinguish between data and variable.	CO1	U
2.	Compare Skewness and Kurtosis.	CO1	U
3.	Explain probit analysis.	CO1	U

(2x 1= 2 weights)

Part A2. Answer any 2 questions from the bunch for CO2. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
4.	Discuss binomial distribution.	CO2	U
5.	Explain Mann-Whitney U test.	CO2	U
6.	Explain Blue Brain project.	CO2	U

(2x 1= 2 weights)

Part A3. Answer any 2 questions from the bunch for CO3. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
7.	Explain the objectives of research.	CO3	U

8.	Summarize the importance of literature review in defining a problem.	CO3	U
9.	Explain the features of good research design.	CO3	U

(2x 1= 2 weights)

Part A4. Answer any 2 questions from the bunch for CO 4. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
10.	Distinguish between technical reports and thesis.	CO4	U
11.	Give five examples of project funding agencies.	CO4	U
12.	Discuss about institutional websites.	CO4	U

(2x 1= 2 weights)

Part B

Part B1. Answer any 3 questions from the bunch for CO3. Each question carries 2 weights

Q. No	Questions	CO	Level of Question																		
13.	<p>Compute the median of the following distribution</p> <table border="1"> <tr> <td>class intervals</td> <td>1-3</td> <td>3-5</td> <td>5-7</td> <td>7-9</td> <td>9-11</td> <td>11-13</td> <td>13-15</td> <td>15-17</td> </tr> <tr> <td>frequencies</td> <td>6</td> <td>53</td> <td>85</td> <td>56</td> <td>21</td> <td>16</td> <td>4</td> <td>4</td> </tr> </table>	class intervals	1-3	3-5	5-7	7-9	9-11	11-13	13-15	15-17	frequencies	6	53	85	56	21	16	4	4	CO1	A
class intervals	1-3	3-5	5-7	7-9	9-11	11-13	13-15	15-17													
frequencies	6	53	85	56	21	16	4	4													
14.	<p>Calculate the standard deviation for the following distributions:</p> <table border="1"> <tr> <td>Values</td> <td>10</td> <td>20</td> <td>30</td> <td>40</td> <td>50</td> <td>60</td> <td>70</td> </tr> <tr> <td>Frequency</td> <td>1</td> <td>5</td> <td>12</td> <td>22</td> <td>17</td> <td>9</td> <td>4</td> </tr> </table>	Values	10	20	30	40	50	60	70	Frequency	1	5	12	22	17	9	4	CO1	A		
Values	10	20	30	40	50	60	70														
Frequency	1	5	12	22	17	9	4														
15.	Explain the graphical method of studying regression.	CO1	U																		

16.	Calculate the Karl Pearson's coefficient of correlation from the following data and interpret its value.	CO1	A																		
	<table border="1"> <tr> <td>ROLL NO</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>marks in accountancy X</td> <td>48</td> <td>35</td> <td>17</td> <td>23</td> <td>47</td> </tr> <tr> <td>marks in statistics Y</td> <td>45</td> <td>20</td> <td>40</td> <td>25</td> <td>45</td> </tr> </table>	ROLL NO	1	2	3	4	5	marks in accountancy X	48	35	17	23	47	marks in statistics Y	45	20	40	25	45		
ROLL NO	1	2	3	4	5																
marks in accountancy X	48	35	17	23	47																
marks in statistics Y	45	20	40	25	45																

(3x 2= 6 weights)

Part B2. Answer any 3 questions from the bunch for CO4. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
17.	Compare Impact factor and citation index.	CO4	U
18.	Explain different types of reports.	CO4	U
19.	Discuss e-books and their advantages.	CO4	U
20.	Describe any five plagiarism checking softwares.	CO4	U

(3x 2= 6 weights)

Part C

Part C1. Answer any 1 question from the bunch for CO1. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
21.	Describe the measures of probability and theorems in probability.	CO2	U
22.	Explain parametric and non-parametric tests with examples.	CO2	U

(1x 5= 5 weights)

Part C2. Answer any 1 question from the bunch for CO2. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
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23.	Discuss the various types of research designs and the factors affecting research design.	CO3	U
24.	Explain the key points of consideration while selecting and formulating a research problem.	CO3	U

(1x 5= 5 weights)

Blueprint model 4BP₄ for 4 COs

Module	CO	Part	Part	Part	Part	Part	Part	Part	Part	Total Weights (30 out of 48)
		A1	A2	A3	A4	B1	B2	C1	C2	
		Any 2 out of 3 questions of				Any 3 out of 4 questions of		Any 1 out of 2 questions of		
		CO1	CO2	CO3	CO4	CO3	CO4	CO1	CO2	
Module I (18 hrs)	CO1	3	0	0	0	4	0	0	0	11
Module II (18 hrs)	CO2	0	3	0	0	0	0	2	0	13
Module III (18 hrs)	CO3	0	0	3	0	0	0	0	2	13
Module IV (18 hrs)	CO4	0	0	0	3	0	4	0	0	11

* End Semester evaluation of the course will be done using any of the blueprint model for 4 COs (4BP₁ to 4BP₆)

SEMESTER I
CORE COURSE
ZO1C01PM25 - ANIMAL DIVERSITY, EVOLUTIONARY,
ETHOLOGICAL, BIOCHEMICAL AND BIOSTATISTICAL METHODS
AND APPROACHES

Total Credits: 4

Total Lecture Hours: 180

Course Outcome

CO1: Compare the taxonomy, classify specimens, construct keys, and identify phylogeny. (Understand)

CO2: Construct evolutionary relationships, generate cladograms, design behavioural studies, and formulate adaptive analyses. (Apply)

CO3: Estimate biomolecules, evaluate buffers, interpret concentrations, assess proteins, enzymes, and cholesterol. (Understand)

CO4: Apply statistics, derive regression, analyze correlation, assess significance, and interpret graphs. (Apply)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	2	1	1	2	3
CO3	2	2	3	1	2
CO4	2	1	1	3	3

Syllabus Content

Module I (CO1)

(36 hrs)

BIOSYSTEMATICS

1. Study of museum specimens - 50 invertebrates and 20 vertebrates (List the studied items with brief descriptions enlisting at least five taxa or taxonomic rank (Diagrams not necessary).
2. Identification of larval forms - any 10 larvae from different taxa (emphasizing phylogenetic, morphological, ecological and pathological significance).

3. Mounting and submission of any three larval forms.

(Diversity should be maintained depending on the number of students and one specimen each should be submitted for the practical examination; repetition should be avoided for examination).

4. Preparation of dichotomous key up to the family of four specimens each from any of the three, from the following five groups (i.e., from insects, spiders, fishes, amphibians and snakes).
5. Preparation of dichotomous key using appropriate software or online tools (students should be familiarized with the computer aided keys).

Module II (CO2)

(36 hrs)

EVOLUTIONARY BIOLOGY AND ETHOLOGY

1. Calculation of gene frequency involving Hardy-Weinberg Law.
2. Preparation of cladogram based on the specimens provided (at least five museum specimens) (OR software programs can be used for construction with more number of specimens).
3. Study on the skull pattern of reptiles, birds & mammals (Any five - Varanus, Crocodile, Bird, Dog, Rabbit, Rat).
4. Behavioural study or activity pattern of any two organism (insects, fish, reptiles, birds, mammals) based on field observation.
5. Study animal behaviour using traditional Indian knowledge and compare it with modern ethology (Hint: frog calls and rainfall forecasting, butterfly migration and flowering cycles, cattle behaviour before natural disasters).

Module III (CO3)

(72 hrs)

BIOCHEMISTRY

1. Study of the structure of biomolecules (carbohydrate, amino acid, cholesterol), using ball and stick models and Protein and Nucleic acid using software tools.
2. Preparation of Buffers of specific pH using pH meter.
3. Calculation of Molality, Normality, percentage W/V, serial dilution and preparation of standard solutions.
4. Preparation of standard curve for protein (by Lowry or Biuret methods), glucose, cholesterol and/or creatinine and estimation of unknown concentration.
5. Estimation of protein or cholesterol from fresh tissue.
6. Estimation of Enzyme activity from fresh tissue (alkaline phosphatase or acid phosphatase).

Module IV (CO4)

(36 hrs)

BIOSTATISTICS

1. Calculation of corrected mean, and standard deviation (Problems can be solved using scientific calculator).
2. Derive regression equation for protein, cholesterol and creatine using Optical density and Concentration.
3. Drawing best line of fit for protein, cholesterol and creatine (Problems can be solved using scientific calculator).
4. Calculation of Pearson correlation coefficient.
5. Calculation of regression coefficient and regression equation ('x' on 'y' only).
6. Calculation of Chi -square value (2x2 table only).
7. Calculation of 't' value (for small sample comparing two samples).
8. MS Excel: Preparation of graphs (bar, histogram, frequency polygon, frequency curve, pie diagram and ogives).
9. MS Excel/PH Stat/SPSS: Basic statistics (mean, median, mode, standard deviation), Correlation Analysis, Regression analysis, Test of significance (T test between two sample or sample and population), Chi-square test, Problems using one way ANOVA.

References

1. Vane-Wright, R. I. (1992). Systematics and diversity. In *Global biodiversity: status of the Earth's living resources* (pp. 7-12). Dordrecht: Springer Netherlands.
2. Shanks, A. (2001). *An identification guide to the larval marine invertebrates of the Pacific Northwest*. Oregon State University Press.
3. Edwards, A. W. F. (2008). GH Hardy (1908) and hardy–weinberg equilibrium. *Genetics*, 179(3), 1143-1150.
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MODEL QUESTION PAPER

(As per blueprint model 4BP1)

M. Sc. Degree (CSS) Examinations Semester I

**ZO1C01PM25- ANIMAL DIVERSITY, EVOLUTIONARY, ETHOLOGICAL,
BIOCHEMICAL AND BIOSTATISTICAL METHODS AND APPROACHES**

Time: 4 Hours

Maximum Weightage: 15

Part A

Part A1. Answer any 2 questions from the bunch for CO1. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
1.	Identify the reptilian skull, label the fossae and the arcade and the bones involved, give an example of any two reptiles with such skull.	CO1	U
2.	Submit a permanently stained unique preparation of any of the larval forms studied and comment on the item.	CO1	U
3.	Report the methods and approaches of the practical by submitting the record book.	CO1	U

(2x 1= 2 weights)

Part A2. Answer any 2 questions from the bunch for CO2. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
4.	In a study of human blood groups in Kerala, it was found that among a population of 600 individuals, 430 were Rh+ and 170 were Rh-. Assuming that this trait (ie being Rh+) is controlled by a dominant allele D. (a) Calculate the allele frequencies of D and d.	CO2	A

	(b) How many of the Rh+ individuals would be expected to be heterozygous?		
5.	Viva on the study conducted on animal behaviour using traditional Indian knowledge and compare it with modern ethology.	CO2	A
6.	In corn, kernel colour is governed by a dominant allele for white color (W) and by a recessive allele (w). A random sample of 90 kernels from a population that is in Hardy Weinberg Equilibrium reveals that 9 kernels are yellow (ww) and 81 kernels are white. a. Calculate the frequencies of the yellow and white alleles in this population. b. Calculate the percentage of this population that is heterozygous.	CO2	A

(2x 1= 2 weights)

Part A3. Answer any 2 questions from the bunch for CO3. Each question carries 1 weight

Q. No	Questions	CO	Level of Question
7.	Calculate the mass of NaOH required to prepare 200mL of 0.1N NaOH.	CO3	U
8.	How to prepare 150mL of 70% alcohol from 95% alcohol.	CO3	U
9.	How to prepare 100mL of 0.1M of NaOH from a stock solution of 4% NaOH.	CO3	U

(2x 1= 2 weights)

Part A4. Answer any 2 questions from the bunch for CO 4. Each question carries 1 weight

Q. No	Questions	CO	Level of Question																						
10.	Calculate standard deviation for the following distribution: <table border="1" style="margin-left: 40px;"> <tr> <td>Values</td> <td>8</td> <td>9</td> <td>15</td> <td>23</td> <td>5</td> <td>11</td> <td>19</td> <td>8</td> <td>10</td> <td>12</td> </tr> <tr> <td>Frequency</td> <td>1</td> <td>2</td> <td>3</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> <td>11</td> </tr> </table>	Values	8	9	15	23	5	11	19	8	10	12	Frequency	1	2	3	5	6	7	8	9	10	11	CO4	A
Values	8	9	15	23	5	11	19	8	10	12															
Frequency	1	2	3	5	6	7	8	9	10	11															
11.	Calculate the mean from the following data: <table border="1" style="margin-left: 40px;"> <tr> <td>No. of leaves (X)</td> <td>5</td> <td>10</td> <td>15</td> <td>20</td> <td>25</td> </tr> <tr> <td>No. of plants (f)</td> <td>3</td> <td>5</td> <td>7</td> <td>3</td> <td>2</td> </tr> </table>	No. of leaves (X)	5	10	15	20	25	No. of plants (f)	3	5	7	3	2	CO4	A										
No. of leaves (X)	5	10	15	20	25																				
No. of plants (f)	3	5	7	3	2																				
12.	Test scores of five students are known to be 85, 78, 92, and 70. If the fifth student scored 88. Write the average score of all five students?	CO4	A																						

(2x 1= 2 weights)

Part B

Part B1. Answer any 3 questions from the bunch for CO3. Each question carries 2 weights

Q. No	Questions	CO	Level of Question
13.	Prepare a standard curve for glucose in the given sample.	CO3	U
14.	Prepare a standard curve for cholesterol in the given sample.	CO3	U
15.	Estimate the concentration of glucose in the given solution.	CO3	U
16.	Estimate the concentration of protein in the given solution.	CO3	U

(3x 2= 6 weights)

Part B2. Answer any 3 questions from the bunch for CO4. Each question carries 2 weights

Q. No	Questions	CO	Level of Question																																	
17.	<p>Sketch an ogive (both less than and more than) from the given data.</p> <table border="1"> <tr> <td>Marks</td> <td>0-20</td> <td>20-40</td> <td>40-60</td> <td>60-80</td> <td>80-100</td> </tr> <tr> <td>No. of students</td> <td>12</td> <td>27</td> <td>20</td> <td>18</td> <td>4</td> </tr> </table>	Marks	0-20	20-40	40-60	60-80	80-100	No. of students	12	27	20	18	4	CO4	A																					
Marks	0-20	20-40	40-60	60-80	80-100																															
No. of students	12	27	20	18	4																															
18.	<p>(a) The average height of 20 students was calculated as 160cm. On verification, it was found that one reading was wrongly recorded as 132 cm instead of 152cm. Estimate the corrected mean height.</p> <p>(b) Estimate the correlation coefficient between weight and length of broad beans using MS Excel.</p> <table border="1"> <tr> <td>Bean No.</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> <tr> <td>Weight (g)</td> <td>0.7</td> <td>1.2</td> <td>0.9</td> <td>1.4</td> <td>1.2</td> <td>1.1</td> <td>1.0</td> <td>0.9</td> <td>1.0</td> <td>0.8</td> </tr> <tr> <td>Length (cm)</td> <td>1.7</td> <td>2.2</td> <td>2.0</td> <td>2.3</td> <td>2.4</td> <td>2.2</td> <td>2.0</td> <td>1.9</td> <td>2.1</td> <td>1.6</td> </tr> </table>	Bean No.	1	2	3	4	5	6	7	8	9	10	Weight (g)	0.7	1.2	0.9	1.4	1.2	1.1	1.0	0.9	1.0	0.8	Length (cm)	1.7	2.2	2.0	2.3	2.4	2.2	2.0	1.9	2.1	1.6	CO4	A
Bean No.	1	2	3	4	5	6	7	8	9	10																										
Weight (g)	0.7	1.2	0.9	1.4	1.2	1.1	1.0	0.9	1.0	0.8																										
Length (cm)	1.7	2.2	2.0	2.3	2.4	2.2	2.0	1.9	2.1	1.6																										
19.	<p>(a) Mean of 100 item was 50, later it was found that 2 items were misread as 92 and 8 instead of 192 and 88. Estimate the corrected mean.</p> <p>(b) The body weight of 16 individuals are given below. Estimate the mean, median and standard deviation of the two groups using MS Excel.</p> <table border="1"> <tr> <td>Group 1 (with exercise)</td> <td>85</td> <td>106</td> <td>75</td> <td>64</td> <td>73</td> <td>46</td> <td>57</td> <td>40</td> </tr> <tr> <td>Group 2 (without exercise)</td> <td>98</td> <td>110</td> <td>123</td> <td>96</td> <td>100</td> <td>130</td> <td>125</td> <td>95</td> </tr> </table>	Group 1 (with exercise)	85	106	75	64	73	46	57	40	Group 2 (without exercise)	98	110	123	96	100	130	125	95	CO4	A															
Group 1 (with exercise)	85	106	75	64	73	46	57	40																												
Group 2 (without exercise)	98	110	123	96	100	130	125	95																												

20.	The arithmetic mean and standard deviation of series of 20 terms were calculated by a student as 20 cm and 50 cm respectively. But while calculating then an item 13 was misread as 30. a. Find the correct arithmetic mean b. Find the correct standard deviation	CO4	A
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(3x 2= 6 weights)

Part C

Part C1. Answer any 1 question from the bunch for CO1. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
21.	Identify the given five specimens by their scientific names. Mention five levels of classification of any two with Phylum as the highest rank in the hierarchy.	CO1	U
22.	Give the dental formula of given two mammalian skulls. Comment on the feeding habits.	CO1	U

(1x 5= 5 weights)

Part C2. Answer any 1 question from the bunch for CO2. Each question carries 5 weights

Q. No	Questions	CO	Level of Question
23.	a. In a population that is in Hardy Weinberg equilibrium, 40% of individuals are recessive homozygotes for a certain trait. In a population of 14600, calculate the percentage of homozygous dominant individuals and heterozygous individuals. b. The human MN blood type antigens are determined by two codominant alleles, LM and LN. The MN blood types and corresponding genotypes of 398 Finns from Karjala are tabulated	CO2	A

	<p>here. Calculate the allelic and genotypic frequencies at the MN locus for the Karjala population.</p> <table border="1"> <thead> <tr> <th>Phenotype</th> <th>Genotype</th> <th>Number</th> </tr> </thead> <tbody> <tr> <td>MM</td> <td>$L^M L^M$</td> <td>182</td> </tr> <tr> <td>MN</td> <td>$L^M L^N$</td> <td>172</td> </tr> <tr> <td>NN</td> <td>$L^N L^N$</td> <td>44</td> </tr> </tbody> </table>	Phenotype	Genotype	Number	MM	$L^M L^M$	182	MN	$L^M L^N$	172	NN	$L^N L^N$	44		
Phenotype	Genotype	Number													
MM	$L^M L^M$	182													
MN	$L^M L^N$	172													
NN	$L^N L^N$	44													
24.	<p>Jeffrey Mitton and his colleagues found three genotypes (R^2R^2, R^2R^3, and R^3R^3) at a locus encoding the enzyme peroxidase in ponderosa pine trees growing in Colorado. The observed numbers of these genotypes at Glacier Lake, Colorado, were:</p> <table border="1"> <thead> <tr> <th>Genotype</th> <th>Number</th> </tr> </thead> <tbody> <tr> <td>R^2R^2</td> <td>135</td> </tr> <tr> <td>R^2R^3</td> <td>44</td> </tr> <tr> <td>R^3R^3</td> <td>11</td> </tr> </tbody> </table> <p>Determine whether the ponderosa pine trees at Glacier Lake, Colorado, in Hardy-Weinberg equilibrium at the peroxidase locus?</p>	Genotype	Number	R^2R^2	135	R^2R^3	44	R^3R^3	11	CO2	A				
Genotype	Number														
R^2R^2	135														
R^2R^3	44														
R^3R^3	11														

(1x 5= 5 weights)

Blueprint model 4BP₁ for 4 COs

Module	CO	Part A1	Part A2	Part A3	Part A4	Part B1	Part B2	Part C1	Part C2	Total Weights (30 out of 48)
		Any 2 out of 3 questions of				Any 3 out of 4 questions of		Any 1 out of 2 questions of		
		CO1	CO2	CO3	CO4	CO3	CO4	CO1	CO2	
Module I (18 hrs)	CO1	3	0	0	0	0	0	2	0	13
Module II (18 hrs)	CO2	0	3	0	0	0	0	2	0	13
Module III (18 hrs)	CO3	0	0	3	0	4	0	0	0	11
Module IV (18 hrs)	CO4	0	0	0	3	0	4	0	0	11

* End Semester evaluation of the course will be done using any of the blueprint model for 4 COs (4BP₁ to 4BP₆)

SEMESTER II

SEMESTER II
CORE COURSE

ZO2C05TM25 – ECOLOGY: PRINCIPLES AND PRACTICES

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Describe the basic concepts of the ecosystem, their relationships and the significance of different ecological interactions. (Understand)

CO2: Summarize the processes that shape the distribution and abundance of different populations. (Understand)

CO3: Explain the various types of population interactions. (Understand)

CO4: Compare the pollution management strategies to utilize resources in a sustainable manner. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	2	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Animal and Physical Environment

Ecosystem concept – structure and function, Productivity, Food chain and food web, Energy flow. Effect of cold and hot temperature on organisms. Global warming and change of species phenology. Effect of soil development on nutrient level. Herbivore population and plant nutrient level. Availability of O₂ and CO₂ on growth and distribution of organisms. Water availability and abundance of organism. Significance of salt concentration in soil and water. Effect of soil and water pH on distribution of organisms. Cybernetic nature of

ecosystem, homeostasis and feedback systems. Animals and nutrient acquisition – herbivory, carnivory, omnivory, detritus feeding. Animal adaptations to thermal environment – thermal balance, poikilotherms, homeotherms, heterotherms. Animal adaptations to moisture environment – maintenance of water balance, response to drought and flooding. Animal adaptations to light environment.

Module II (CO 2)

(18 hrs)

Population Ecology

Properties – patterns of dispersion, dispersal movements, age structure, sex ratio, life table, survivorship curve, density, population growth-exponential and logistic growth, time lags, carrying capacity. Population growth. Density dependent and density independent influences. Population fluctuations and cycle. Extinction – deterministic extinction and stochastic extinction. Life history strategies – Reproductive strategies, r and k selection. Human population growth. Concept of ecological foot print. Population regulation – dispersal, social dominance, territoriality: types of territory, territorial defense, floaters, home range. Aggregation, Allee's principle, Isolation, Metapopulation - Concept, Structure.

Module III (CO 3)

(18 hrs)

Population Interactions: Competition and Predation

Interspecific competition – Competitive Exclusion Principle, Resource partitioning and utilization. Niche, Niche overlap, Niche width, Niche responses-niche compression and niche shift. Character displacement. Ecological and evolutionary effects of competition. Predation – Antipredator adaptations. Foraging theory – optimal diet, foraging efficiency, risk-sensitive foraging. Animal prey defence – chemical defence, warning coloration and mimicry, cryptic colouration, armor and defence, behavioural defence, predatory satiation. Predator offence – hunting tactics, cryptic coloration and mimicry in predators, adaptations of hunting. Cannibalism, Intraguild predation (IGP).

Population Interactions: Parasitism and mutualism

Characteristics and life-cycle of parasite, host response to parasitism – biochemical, abnormal growth, sterility, behavioural change, mate selection. Social parasitism – Brood parasitism and kleptoparasitism. Types of defence against parasites by host. Invasive parasite. Parasitism and climate change. Non-native parasite and biological control. Mutualism –

Origin and types. Dispersive mutualism, defensive mutualism, resource based mutualism. Mutualistic relationship of human with crops.

Module IV (CO 4)

(18 hrs)

Applied Ecology

Air, water, soil and radioactive pollution – Sources, causes and consequences. Disposal of radioactive waste. Ecological indicators. Concept of waste – types and sources of solid waste. Health and environmental implications. E-waste types and management aspects. Environmental biotechnology and solid waste management – Aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and Sewages. Scope of bioremediation. Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters.

Resource Ecology

Currents status of forest resources and deforestation in India. Fresh water sources, water scarcity and water conservation measures. Wet lands - its importance, reclamation and conservation measures. Sand mining and its impacts.

Energy resources – solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Recent issues in energy production and utilization. Green technology and sustainable development. Depletion of natural resources and its impacts on life.

Ecosystem monitoring – GIS and its application, Role of remote sensing in ecology. Environmental Impact Assessment (EIA)-Tools and technique. Ecosystem modelling (Brief account only).

References

1. Abbasi, S.A. & Ramasami, E.V. (1999). *Biotechnological Methods of Pollution Control*. (1st Ed.). Universities Press, Orient Longman Ltd, India.
2. Benton, A.H. & Werner, W.E. (1974). *Field Biology and Ecology*.(3rd Ed.). Tata McGraw Hill, New Delhi, India.
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Publishers, Massachusetts, USA.

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SEMESTER II
CORE COURSE

ZO2C06TM25 - DEVELOPMENTAL BIOLOGY

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Explain the basic concepts in Developmental Biology. (Understand)

CO2: Discuss the basic genetic development process in Drosophila. (Understand)

CO3: Describe the mechanisms of axis and pattern formation in amphibians. (Understand)

CO4: Compare different cellular interactions involved in the development, metamorphosis and regeneration of organisms and the role of developmental biology in human welfare. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	1	2
CO2	2	3	2	1	2
CO3	2	3	2	1	2
CO4	2	3	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Introduction: Basic Concepts of Development

Potency of embryonic cells (Stem cells), Commitment, Specification (Autonomous and Conditional), Induction, eye lens induction, Regional specificity of induction, Genetic specificity of induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages. Genomic equivalence and Cytoplasmic determinants, DNA methylation, Genomic imprinting.

Gametogenesis, Fertilization and Early development

Spermatogenesis, Oogenesis, Fertilization - (biochemical and molecular aspects, cell surface

molecules in sperm-egg recognition), Polyspermy. Early development and axis specification in *Caenorhabditis elegans*, Vulval induction in *C. elegans*. Mechanisms and significance of cleavage.

Module II (CO 2)

(18 hrs)

Development of Model organism - Drosophila

Early development and axis specification in *Drosophila* (cleavage, mid-blastula transition, gastrulation). 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, Dorsal protein gradient.

Module III (CO 3)

(18 hrs)

Axis and Pattern Formation in Amphibians

Axis formation in Amphibia - Anterior-posterior patterning in Amphibia. Hox code hypothesis. Nieuwkoop centre and mesodermal polarity. Molecular basis of mesoderm induction. Transcription factors induced in the organizer. Neural induction.

Module IV (CO 4)

(18 hrs)

Cellular Interactions in Development

Paracrine factors - Hedgehog family, Wnt family, TGF, BMP. Surface receptors and signal transduction pathway - RTK pathway, Smad pathway, Wnt pathway, Hedgehog pathway and cell death pathway.

Metamorphosis and Regeneration

Metamorphosis of Amphibians and Insects; Hormonal control of metamorphosis. Heterochrony, Neoteny, Progenesis (Brief accounts); Regeneration - different types of regeneration; Histological processes during regeneration; Polarity and Metaplasia in regeneration; Lens regeneration in Amphibia.

Human Welfare and Developmental Biology

Gene-phenotype relationship, Autophenotype, Allophenotype and Pleiotrophy; Malformations and disruptions, Environmental oestrogens.

References

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SEMESTER II
CORE COURSE

ZO2C07TM25 - GENETICS AND BIOINFORMATICS

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Explain the principles and mechanisms of inheritance. (Understand)

CO2: Explain the fine gene structure and modern finding on the nature of gene. (Understand)

CO3: Discuss DNA replication processes and mutations, and explore their impact on human, quantitative, and population genetics. (Understand)

CO4: Explain different databases and structure prediction methods using bioinformatics tools in research. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	3	1	2
CO3	3	3	3	1	2
CO4	2	2	3	2	2

Syllabus Content

GENETICS **(54 hrs)**

Module 1 (CO 1) **(18 hrs)**

Principles of Genetic Transmission

Basic principles of inheritance: Alleles, Pseudo alleles, Dominance, Segregation, Independent assortment, Test cross and ratios.

Extensions of Mendelian Principles: Codominance, Incomplete Dominance, Gene interactions with Epistasis, Pleiotropy, Penetrance and Expressivity, Phenocopy.

Linkage, Recombination and Crossing over, Cytogenetic Mapping

Linkage, Recombination, Stern's experiment, Crossing over as the physical basis of recombination, Molecular mechanism of crossing over and recombination, Holiday Model.

Mechanisms of genetic exchange in Bacteria.

Recombination mapping with a three point test cross in *Drosophila*, Interference and the Coefficient of Coincidence. Mitotic recombination, Evolutionary significance of recombination. Mapping genes using conjugation data, Fine structure Mapping of Phage genes: Complementation Mapping, Deletion Mapping.

Module II (CO 2)

(18 hrs)

Molecular Organization of Chromosomes

DNA, Histone, Chromatin, Euchromatin and heterochromatin.

Genome size and C – value paradox, Chromatin Structure and levels of DNA packaging in Prokaryotic and Eukaryotic chromosomes, Molecular structure of Centromere and Telomere, Telomere shortening and Aging (Werner's syndrome), Repeated DNA sequences in Eukaryotic Genome: Highly repetitive, Moderately repetitive, Single copy, Kinetics of renaturation, Cot Curve.

Gene Fine Structure

Classical versus Molecular concept of the gene, Cis-Trans test for functional allelism, Fine structure of the phage T4 rII locus, Modern findings on the nature of gene: Interrupted genes in eukaryotes, Exons and introns, Genes with in genes in phage ϕ x174, Gene synthesis: in vitro synthesis - Works of Watson and Crick, Khorana, Kornberg and Nirenberg.

Transposable genetic elements

Transposable elements in Bacteria, Cut and Paste transposons in Eukaryotes, Retrotransposons Transposable elements in Humans. Genetic and evolutionary significance of transposable elements.

Module III (CO 3)

(18 hrs)

Replication and Mutation

Meselson and Stahl Experiment, Semiconservative replication. Unidirectional replication, Bidirectional replication, Theta replication, Rolling circle replication, eukaryotic replication and Replication Machineries – prokaryotes and eukaryotes.

Mutagenesis (Somatic or germinal mutation, Spontaneous or induced Mutation, Conditional lethal mutation, Variation in chromosome Number and Structure: Aneuploidy, Deletions and Duplications, Inversions, Translocations (Brief account only) and Molecular Mechanism of Mutation, Tautomeric shift, DNA Repair Mechanisms, Inherited Human Diseases with defects in DNA repair, Gene conversion, The Ames test.

Human Genetics, Quantitative Genetics and Population Genetics

Karyotype, Chromosome banding techniques, Pedigree analysis, anticipation, Lod Score, Complex traits, Quantitative traits, Threshold traits. Analysis of quantitative traits: The Multiple Factor Hypothesis, Broad sense heritability, Narrow sense heritability. Artificial selection, Correlations between Relatives.

The theory of allele frequencies and allelic natural selection. Applications of Molecular Genetics. Identification of human genes and diagnosis of human diseases. Uni parental Disomy, Huntington's disease, Fragile X syndrome, Cystic fibrosis. Gene therapy- SCID-Autosomal disease of immune system, DNA profiling, Micro RNA, Si RNA and their control in Genetic disorders. Mitochondrial gene in Aging and Human Disease.

Epigenetics

Epigenetics, Histone code hypothesis. Chromatin modifications and their mechanisms of action: Modification of histone proteins-Acetylation, phosphorylation, methylation, ubiquitylation, Sumoylation. Chromatin remodeling, Genomic imprinting, X chromosome inactivation, Gene Silencing. Epigenetics in Drosophila: Position effect variegation (PEV), Gene silencing - Polycomb Group Genes (PcG) - Yeast and Drosophila models.

BIOINFORMATICS

Module IV (CO 4)

(18 hrs)

Biological Databases

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: SWISSPROT, PIR; steps involved in use and interpretation of results.

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

Sequence Analysis

Types of sequence alignment, methods of sequence alignment, scoring schemes, Phylogenetic trees - CLUSTAL W and CLUSTAL ω , PHYLIP.

Genomics and Proteomics and Systems Biology

Structural genomics, functional genomics, comparative genomics, data mining, proteomics - Microarrays. Protein modelling and drug designing.

System Biology - metabolomics, gene network, synthetic biology. (Brief Account only)

References

GENETICS

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BIOINFORMATICS

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SEMESTER II

CORE COURSE

ZO2C08TM25 MICROBIOLOGY

Total Credits: 3

Total Lecture Hours: 54

Course Outcome

CO1: Explain the basic microbial structure, function and taxonomy. (Understand)

CO2: Summarize different aspects of microbial growth, motility and cultivation. (Understand)

CO3: Explain principles, tools, techniques in epidemiology and antimicrobial therapy.
(Understand)

CO4: Describe the role of microbes in food and food spoilage. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	2
CO2	2	3	3	1	2
CO3	2	2	3	2	2
CO4	2	2	3	2	2

Syllabus Content

Module I (CO 1)

(13.5 hrs)

Microbial Diversity

Prokaryotic and eukaryotic microbial diversity. The bacteria and the archaea. Principles of bacterial taxonomy Molecular methods in taxonomy. Morphology and structure of bacteria. Surface structures and inclusions of bacteria. Viruses- unique properties, morphology and structure. Gram positive and Gram negative bacteria. Virus structure, viral cultivation and replication. Viral diversity –bacterial, plant and animal viruses. Fungi – properties and classification.

Module II (CO 2)

(13.5 hrs)

Microbial Growth

Factors influencing microbial growth. Environmental and nutritional factors. Nutritional types

of bacteria. Microbial locomotion – flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis and other taxes. Cultivation of bacteria- culture media and methods. Measurement of bacterial growth. Bacterial growth curve. Binary fission, Growth cycle, thermophiles, mesophiles, halophiles, psychrophiles. Continuous cultures. Maintenance and transport of cultures.

Module III (CO 3)

(13.5 hrs)

Epidemiology of Infectious Diseases

Epidemiological Terminology. Measuring frequency: The epidemiologist's tools. The infectious disease cycle: Virulence and the mode of transmission, Control of epidemics. Emerging and re-emerging infectious diseases and pathogens. Nosocomial infections.

Drugs and Microbes

Principles and terminology of antimicrobial therapy. Drug, Host-microbe interactions. Characteristic interactions between drug and microbe. Mechanism of drug action. The acquisition of drug resistance. Antibacterial drugs. Synthetic antibacterial drugs. Agents to treat fungal infections. Antiprotozoal and antiviral drugs, Allergic responses to drugs.

Module IV (CO 4)

(13.5 hrs)

Basics of Food Microbiology

Scope of Food Microbiology. Role of microorganisms in food. Different types of microorganisms in food – Bacteria-beneficial, bacteria causing spoilage of food; Fungus-beneficial (Yeast, mushroom & mold); harmful fungi; Viruses causing food borne diseases; Protozoa-Food borne illnesses.

Food spoilage-factors affecting food spoilage, Causes, types of food spoilage., spoilage patterns in different food types (e.g., dairy, meat, vegetables). Indicators of spoilage.

Control Measures of microbes in food-Physical, Chemical, Biological and HACCP

Food Safety and Quality Assurance- International food safety organizations (e.g., WHO, FDA, ISO), Food safety regulations and standards.

Emerging foodborne pathogens & diseases caused by them- *Escherichia coli* O157, *Listeria monocytogenes*, *Clostridium difficile*, Prevention & Control of these diseases. Indicators of food microbial quality & safety: *Coliforms*, *Enterococci*, *Salmonella*, *Clostridium perfringens* Spores, *Listeria* Sps.

Health benefits of Probiotics, Prebiotics, Symbiotic, Nutraceuticals & Single cell protein (Brief account only).

References

1. Arora, D.R. & Arora, B. (2008). *Text Book of Microbiology*. (3rd Ed.). CBS Publishers and Distributors, New Delhi, India.
2. Chakraborty, P. A. (2013). *Text Book of Microbiology*. (3rd Ed.). New Central Book Agency, New Delhi, India.
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SEMESTER II
CORE COURSE

**ZO2C02PM25- METHODS AND APPROACHES IN ECOLOGY,
DEVELOPMENTAL BIOLOGY, GENETICS, BIOINFORMATICS AND
MICROBIOLOGY**

Total Credits: 4

Total Lecture Hours: 180

Course Outcome

CO1: Compare ecosystems, analyze water and soil parameters, assess plankton diversity.
(Understand)

CO2: Identify developmental stages, interpret embryo sections, assess staining, compare placentas. (Understand)

CO3: Construct phylogenetic tree, solve genetic problems, analyze Drosophila traits and retrieve data using bioinformatics tools. (Apply)

CO4: Show microbial techniques, assess culture methods, analyze identification tests, interpret antibiotic sensitivity. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	3	2	1	2
CO3	2	2	3	2	3
CO4	3	2	3	1	2

Syllabus content

Module I (CO1)

(54 hrs)

ECOLOGY

1. Study of Pond/ Wetland/ River ecosystem (any one) – Separate work book should be maintained by each student specifying objectives and methods adopted based on field study.
2. Ecological analysis - Estimation of following parameters Water - Salinity, Phosphates, Nitrate, pH & Conductivity. Soil - Organic Carbon and Chlorides.

3. Separation and identification of soil arthropods using Berlese funnel.
(A minimum of five specimens should be reported with the comments in practical record)
4. Qualitative and Quantitative study of marine/freshwater planktons.
5. Collection and temporary mounting of minimum 3 freshwater plankton (Group/Generic level identification is necessary).
6. Viva based on field study.

Module II (CO2)

(36 hrs)

DEVELOPMENTAL BIOLOGY

1. Study of the developmental stages of *Drosophila*.
2. Study of the developmental stages of Frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill) using permanent slides/ Diagrams.
3. Study of serial sections of embryo (tadpole/chick).
4. Vital staining of early gastrula of chick – Window method.
5. Blastoderm mounting and age determination of chick embryo using vital stains.
6. Morphological and histological details of different types of mammalian placenta.

Module III (CO3)

(36 hrs)

GENETICS & BIOINFORMATICS

1. Culture, sexing and etherization of *Drosophila*.
2. Study of Mutants in *Drosophila*.
3. Genetics problems (Di hybrid cross, test cross and sex linked inheritance).
4. Gene order mapping in three point cross (Data to be provided).
5. Data base search and data retrieval-using NCBI, SWISS-PROT, PDB, Expasy.
6. Methods of sequence alignment-BLAST and Clustal ω .
7. Phylogenetic tree using MESQUITE/ MEGA/ PHYLIP.
8. Gene Prediction using GENSCAN/ GRAI.
9. Protein structure visualization using RASMOL.

Module IV (CO4)

(54 hrs)

MICROBIOLOGY

1. Sterilization, disinfection and safety in microbiological laboratory.

2. Preparation of culture media.
Liquid media (Nutrient broth, Peptone water).
Solid media (Nutrient Agar, Mac Conkey Agar).
Semi-solid agar, Firm agar.
3. Culturing of microorganism. Broth culture.
Pure culture techniques- streak plate, pour plate culture, lawn culture, stab culture.
4. Serial dilution and standard plate count, calculation of CFU/ml in water samples.
5. Isolation and preservation of bacterial culture.
6. Identification of microorganisms.
Staining techniques - Gram staining of mixed cultures, negative staining and spore staining, oxidase test, catalase test.
7. Oxidation/fermentation (O/F) test.
8. Antibiotic sensitivity test.
9. Staining and enumeration of microorganisms using
 - (a) haemocytometer.
 - (b) nephelometry/ turbidimetry.
10. Environmental sample analysis. Coliform count in water.
Isolation and enumeration of soil bacteria.
11. Identification of symbiotic bacterioids from root nodules of leguminous plants.
12. Bacteriological analysis of milk- methylene blue reductase test.

References

1. Henderson, P. A. (2003). *Practical methods in ecology*. John Wiley & Sons.
2. Parsons, T. R. (2013). *A manual of chemical & biological methods for seawater analysis*. elsevier.
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SEMESTER III

SEMESTER III

CORE COURSE

ZO3C09TM25 - ANIMAL PHYSIOLOGY

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Explain the physiology of digestion, absorption, circulation and respiration. (Understand)

CO2: Describe the nerve and sensory effector physiology. (Understand)

CO3: Compare muscle physiology and correlate homeostasis in organisms. (Understand)

CO4: Explain the relationship of endocrine system and reproductive system with other systems.
(Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Nutrition, Digestion and absorption

Types of nutrition, Structure of human digestive system with special emphasis to functional anatomy of stomach and intestine. Secretory functions of alimentary canal - hormones and enzymes. Gastro intestinal disorders. Human digestive system, Physiology of digestion and absorption (A brief account on vertebrates and invertebrates), Neural regulation of thirst, Events of absorptive and post absorptive states - their neural and endocrine regulation, Physiology of starvation and obesity.

Circulation

Circulatory mechanisms in different animal groups, Haemodynamics, Blood volume and its regulation, Comparative anatomy of heart structure in different animals, Myogenic heart,

Conducting system, Cardiac cycle, Cardiac output, stroke volume, Neural and chemical regulation of cardiac activity, blood pressure, ECG - its principle and significance. Effects of exercise on cardio-vascular physiology.

Respiration

Anatomy of respiratory organs and mechanism of respiration in invertebrates and vertebrates, pulmonary ventilation, transport and exchange of gases, surfactants, Neural and chemical regulation of respiration. Respiration in unusual environment – foetal and neonatal respiration, high altitude, diving.

Module II (CO 2)

(18 hrs)

Nerve Physiology

Neuro anatomy of central and peripheral nervous system, Neuromuscular junction-organization and properties, neurotransmitters, Special characteristics of synaptic transmission, Mechanism of excitatory and inhibitory pathway, neuromodulators. Neural control of muscle tone and posture.

Sensory and Effector Physiology

Classification of somatic senses and somatic receptors, modality of sensation, exteroceptors, interoceptors, Chemo receptors: Mechanism of reception. Mechanoreceptors: Mechanism of hearing and equilibrium. Photo receptors: Structure of invertebrate and vertebrate eye. Physiology of vision. Pain receptors: Headache, pain suppression (analgesia). Tactile receptors: Mechanism of transmission of signals.

Module III (CO 3)

(18 hrs)

Muscle Physiology

Skeletal muscle- ultra structure and molecular organization. Red and white muscles, Mechanism of muscle contraction and relaxation. Energetics of muscle contraction. Catch muscle and fibrillar muscle.

Osmoregulation and Excretion

Osmoregulation in fresh water, marine and terrestrial animals. Comparative physiology of excretion in different animals, Hormonal regulation of urine concentration, Regulation of water balance, electrolyte balance and acid-base balance. Role of kidney in maintaining homeostasis. Micturition, Dialysis, Kidney transplantation.

Thermoregulation

Temperature compensation and temperature regulation in poikilotherms and homeotherms, Comfort zone, body temperature – physical, chemical, neural regulation. Adaptations for extreme environments, aestivation and hibernation.

Module IV (CO 4)

(18 hrs)

Endocrinology

Invertebrate and vertebrate endocrine glands, Synthesis (Peptide- Insulin, Steroid hormones, Amines- Thyroid) physiological role and mechanism of hormone action. Bioamines, Ecosanoids, Chalcones, Lumones, Phytohormones, Synthetic hormones, Pheromones.

Reproductive physiology

Anatomy and histology of Testis and Ovary, Hormonal regulation of gametogenesis, Physiology of implantation, pregnancy, parturition, and lactation. Prenatal diagnostic tests- Amniocentesis, Ultrasonography, Chorionic villus sampling, Maternal Serum Alpha-Fetoprotein (MSAFP).

References

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23. Willmer, P., Stone, G., & Johnston, I. (2009). *Environmental physiology of animals*. John Wiley & Sons.

SEMESTER III

CORE COURSE

ZO3C10TM25 – CELL BIOLOGY

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Describe different models, structures and functions of the cell membrane. (Understand)

CO2: Explain the structure and function of cell organelles and their roles in cellular processes. (Understand)

CO3: Compare different types of cell communication and signaling pathways. (Understand)

CO4: Interpret the processes of cell organization, cell movement and cell growth. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Cell Membrane & Cell Interactions

Membrane models, Membrane structure, chemistry and functions, dynamic nature of the plasma membrane, membrane potentials, ion channels, membrane transport: active & bulk transport. Extracellular matrix: Basement membrane, Collagen, Proteoglycans, Fibronectin and Laminin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and Hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens. Cell Junctions: Tight junctions, Gap junctions, Desmosomes and Plasmodesmata.

Module II (CO 2)

(18 hrs)

Cell Organelles

Ribosome- structure and functions, Endoplasmic reticulum – protein insertion, protein folding, signal sequences and signal hypothesis, Golgi complex-protein glycosylation and protein sorting, mechanism of vesicular transport, Mitochondria-structure and functions, Lysosomes, Peroxisomes, Glyoxysomes. Nucleus and Nuclear membrane.

Module III (CO 3)

(18 hrs)

Cell Signaling

Basic principles of cell communication. Extracellular messengers (signaling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers. 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 – role of protein kinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, JAK-STAT pathway, Calcium phosphatidyl - inositol pathway, PhosphoInositide 3-kinase (PI-3 kinase), Transforming growth factor (TGF) signaling pathway. Regulation of signaling pathways. Convergence, divergence and crosstalk among different pathways.

Module IV (CO 4)

(18 hrs)

Cell organization and Cell movement

Structure and organization of Microtubules, Intermediate filaments & Microfilaments, Molecular motors.

Cell Growth

Cell cycle: Stages in cell cycle - Mitosis, Meiosis, Control of cell cycle - Cyclin, CDKs, Phase dependent cyclic CDK complexes. Checkpoints in cell cycle. Apoptosis- extrinsic and intrinsic pathways, Caspases, Proteins associated with the apoptotic pathways, significance of apoptosis.

References

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SEMESTER III

CORE COURSE

**ZO3C11TM25 - BIOPHYSICS, INSTRUMENTATION AND
BIOLOGICAL TECHNIQUES**

Total Credits: 4

Total Lecture Hours: 72

Course Outcome

CO1: Explain diffusion, osmosis, bioenergetics and radiation biophysics (Understand).

CO2: Compare different microscopy and histological techniques (Understand).

CO3: Explain the principles and working of different separation techniques (Understand).

CO4: Compare the principles and applications of various advanced techniques (Understand).

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	2
CO2	2	2	3	1	2
CO3	2	2	3	1	2
CO4	2	2	3	1	2

Syllabus Content

BIOPHYSICS

Module 1 (CO 1)

(18 hrs)

Diffusion and Osmosis

Diffusion – Kinetics of diffusion. Fick's law and diffusion coefficient. Gibb's Donnan equilibrium. Application of diffusion processes in biology: haemolysis. Vant Hoff's laws. Osmotic concentration, Osmotic pressure and osmotic gradient. Biological significance of osmosis in animals and plants.

Bioenergetics

Thermodynamics – Laws of thermodynamics. Reversible thermodynamics and irreversible thermodynamics; Systems – open, closed and isolated. Photo bioenergetics. Photosynthesis – light and dark reactions, Redox couple and redox potential. Chemo-bioenergetics: electron

transport and oxidative phosphorylation, Chemiosmotic theory and binding change mechanism of ATP synthesis.

Radiation Biophysics

Ionizing radiations, units of radioactivity, exposure and dose.

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. Nuclear medicine: Internally administered radioisotopes. Radioiodine in thyroid function analysis.

INSTRUMENTATION & BIOLOGICAL TECHNIQUES (54 hrs)

Module II (CO 2) (18 hrs)

Microscopy and Histological Techniques

Microscopy

Differential Interference contrast (Nomarsky) microscopy, Fluorescence microscopy, Confocal microscope, Scanning Tunnelling, Electron microscope - TEM, SEM, Specimen preparation- Shadow casting, Freeze fracturing, Freeze etching, Negative staining. Microphotography, Atomic force microscope.

Histological Techniques

Types of microtomes and microtomy. Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Cytochemical and histological method, Histochemistry of nucleic acids, detection of carbohydrates, proteins and lipids.

Module III (CO 3) (18 hrs)

Separation Techniques

Centrifugation

Basic principle and application. Differential, density gradient and ultracentrifugation.

Chromatography

Basic principles, working and applications of Thin-layer chromatography, Ion – exchange and Affinity chromatography; High performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC), Gel permeation chromatography.

Electrophoresis

Gel electrophoresis– AGE, PAGE, SDS and non SDS, 2D Gel electrophoresis, Isoelectric

focusing, Density gradient gel electrophoresis, Disc electrophoresis, High voltage electrophoresis, Capillary gel electrophoresis, Electrophoretic mobility shift assay (EMSA).

Module IV (CO 4)

(18 hrs)

Advanced Techniques and Applications

Colorimetry

Principle and applications of colorimetry and spectrophotometry- Beer Lambert law.

Spectroscopy

Fourier-Transform infrared spectroscopy (FTIR), Raman spectroscopy, Circular dichroism spectroscopy, Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic- resonance spectroscopy (NMR) and Electron Spin Resonance (ESR) spectroscopy, Mass spectroscopy- Different types and applications: MALDI-TOF, LCMS, Tandem Mass Spectrometry.

Radioisotope Detection and Measurement

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

Biomimetics technology

Principles and applications-Bio-Nanorobotics, Artificial muscles using Electroactive polymers, Multifunctional materials.

References

1. Ackerman, E. (1979). *Biophysical science*. New Jersey, USA: Prentice Hall Inc.
2. Alonso, A. & Arrondo, J.L.R. (2006). *Advanced Techniques in Biophysics*.UK: Springer.
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4. Baker, E.J. & Silvertone, R.E. (1987). *Introduction to Medical Laboratory Technology* (5th Ed., pp. 299-426). London, UK: ELBS.
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17. Srivastava, P.K. (2006). *Elementary Biophysics- An Introduction*. New Delhi: Narosa Publishing hous
18. Varghese, T., & Balakrishna, K.M. (2012). *Nano Technology- An Introduction to Synthesis, Properties and Applications of Nano Materials*. New Delhi: Atlantic Publishers and Distributors Pvt.Ltd
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SEMESTER III

CORE COURSE

ZO3C12TM25 - BIOTECHNOLOGY

Total Credits: 3

Total Lecture Hours: 54

Course Outcome

CO1: Explain the basic concepts, tools and recent trends in biotechnology. (Understand)

CO2: Describe various recombinant DNA techniques for manipulation of the genetic material.
(Understand)

CO3: Explain the advanced techniques in biotechnology. (Understand)

CO4: Explain application of biotechnology, nanotechnology with emphasis on the bioethical concerns. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	2	2	3	2	2
CO4	2	2	3	2	2

Syllabus Content

Module I (CO 1)

(13.5 hrs)

Introduction, Tools and Recent trends in Biotechnology

Definitions and scope of Biotechnology. Biotechnology in India.

Recombinant DNA (Rdna) and cloning, Restriction enzymes and DNA modifying enzymes.

Vectors: cloning and expression vectors - Plasmids, bacteriophage vectors, vectors with combination features- cosmids, phagemids, pUC19 and Bluescript vectors, viral vectors, SV40, shuttle vectors, BAC and YAC vectors. Adaptors, Linkers.

Recent trends - Synthetic Biology– Genome designing, artificial cells, protein engineering, applications of synthetic biology. Stem cells and regenerative medicine-Induced pluripotent stem cells (iPS). Gene silencing- Antisense RNA Technology, RNA interference, microRNA,

DICER, RISC, Applications. Gene knockout technology: methods and applications. CRISPR-CAS9 system. Ethical, legal, and social issues of Biotechnology.

Module II (CO 2)

(13.5 hrs)

Techniques in Recombinant DNA Technology

Methods of gene transfer: chemical transfection methods: calcium chloride, PEG, polyplex, DEAE dextran. Physical methods: electroporation, microinjection, particle bombardment, ultrasonication, liposome mediated transfer. Biological methods: use of vectors, Agrobacterium mediated gene transfer, Selection and screening of recombinants, Antibiotic resistance markers, insertional activation, blue white screening, Generation of cDNA and genomic library.

Module III (CO 3)

(13.5 hrs)

Advanced techniques in Biotechnology

Blotting techniques: southern, northern, southwestern. Polymerase chain Reaction- different types and applications, Gene cloning, DNA finger printing DNA foot printing, gel shift analysis, DNA microarray, RFLP, RAPD, advanced molecular markers, Chromosome walking, chromosome jumping, Site directed Mutagenesis: methods. DNA sequencing methods- Maxam and Gilbert chemical degradation method, Sanger and Coulson method, Automated DNA sequencers. Protein sequencing methods.

Module IV (CO 4)

(13.5 hrs)

Animal Biotechnology and Health care

Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, Growth media- types, biology and characterization of cultured cells. Cryopreservation and maintenance of cell line, Transgenic Animals and plants-Production and Application, molecular pharming, mention pros and cons of Genetically modified organisms (GMO's).

Useful products - Vaccines, Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferons. Biosensors and Biochip. Diagnosis of diseases. Gene therapy. Transplantation of bone marrow, artificial skin.

Biotechnology in Industry, Agriculture and Environment

Fermentation technology – Stages of fermentation - Fermentation products – (antibiotics, organic acids and vitamins). Transgenic plants, Biological nitrogen fixation; Nif genes, Nitrogen

fixers – Bio fertilizers (*Rhizobium*, *Azotobacter*, *Azospirillum*, VAM) - Bio pesticides- (Bacterial, Fungal, Viral). Terminator gene technology.

Nanobiotechnology

Introduction, Nanobiotechnological devices, Types and applications of Nanobiosensors, Drug delivery technologies, personalized nanomedicine.

Intellectual Property Rights, Biosafety and Bioethics

Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights. Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments, IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Biosafety concepts and issues. Biosafety protocol 2000. Bioethics: Principles of bioethics: autonomy, human rights.

References

1. Click, B. R. & Pasternak. (2002). *Molecular Biotechnology: Principle and applications of recombinant DNA*. ASM Press.
2. Dale, Jeremy, W., Schantz, & Malcom, V. (2002). *From Gene to Genomes*. John Wiley and Sons Ltd, NY, USA.
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SEMESTER III

CORE COURSE

**ZO3C03PM25 - METHODS AND APPROACHES IN PHYSIOLOGY,
CYTOLOGY, BIOPHYSICS AND BIOTECHNOLOGY**

Total Credits: 4

Total Lecture Hours: 180

Course Outcome

CO1: Examine enzyme activity, assess physiological responses, interpret blood parameters, evaluate muscle function. (Apply)

CO2: Determine cell division, assess chromosome structure, interpret staining results, evaluate organelle isolation. (Apply)

CO3: Compare microscopy techniques, use camera lucida, analyse samples, perform TLC. (Apply)

CO4: Examine electrophoresis techniques, isolate genomic and plasmid DNA efficiently. (Apply)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	3
CO2	2	1	1	2	3
CO3	1	1	2	2	3
CO4	1	1	2	2	3

Syllabus Content

Module I (CO1)

(72 hrs)

ANIMAL PHYSIOLOGY

1. Rate of salivary amylase activity on starch (colorimetry).
2. Effect of different pH on salivary amylase activity (colorimetry).
3. Influence of temperature on salivary amylase activity – Calculation of Q₁₀.
4. Effect of drugs on the heartbeat of cockroach (Result with graphical representation corresponding to different concentration and time intervals expected).

5. Oxygen consumption in fish (normal and stressed).
6. Kymograph: working principle and applications.
7. 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:
 - Muscle Twitch and the Latent Period
 - The effect of stimulus Voltage on Skeletal Muscle Contraction Tetanus and Fatigue
 - Receptor Potential
 - The Action Potential Threshold
8. Importance of Voltage-Gated Na⁺ Channels.
9. Differential count of human WBC.
10. Haematocrit and ESR of human blood.
11. Feeding activity of Paramecium.
12. 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.

Module II (CO2)

(54 hrs)

CELL BIOLOGY

1. Squash preparation of grasshopper testis to study meiotic stages.
2. Squash preparation and identification of salivary gland chromosomes in *Drosophila/Chironomus* larva.
3. Determination of mitotic index in the squash preparation of onion root tip.
4. Effect of drugs on cell division (Colchicine or any other inhibitor).
5. Live staining of cells using vital stains and viability study.
6. Cell fractionation and differential centrifugation to isolate mitochondria and nuclei.
7. Preparation of microtome section & spreading.
8. Histochemical staining of carbohydrates (PAS), protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain).

Module III (CO3)

(36 hrs)

BIOPHYSICS/ INSTRUMENTATION/ BIOLOGICAL TECHNIQUE

1. Micrometry- principle and measurement of microscopic objects: Low power and high power.
2. Camera Lucida – Diagrammatic representation of specimen using camera lucida.
3. Principle and working of phase contrast microscope, Micro-photographic equipment.
4. Identification of absorption maxima of the given sample by colorimetry.
5. TLC using amino acids from purified samples and calculation of Rf values.
6. Analysis of biological materials (Arthropodan perilymph) using TLC.

Module IV (CO4)

(18 hrs)

BIOTECHNOLOGY

1. Gel electrophoresis of protein and nucleic acids.
2. Isolation of genomic and plasmid DNA.

Note:

Good laboratory practices and green protocol should be practiced in the lab. 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.

References

1. Ramanathan, R. (2023). *Physiology Practical Manual, -E-Book: Physiology Practical Manual, -E-Book*. Elsevier Health Sciences.
2. Anggun, D. P. (2021). The Development of Animal Physiology Handbook Based on Scientific Approached for Students at Biology Program. *Jurnal Kiprah*, 9(1), 67-73.
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SEMESTER – IV

ELECTIVE BUNCH – A
MOLECULAR BIOLOGY

SEMESTER IV

ELECTIVE BUNCH A – MOLECULAR BIOLOGY

ZO4E01TM25 – MOLECULAR BIOLOGY

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Explain the structure, and properties of nucleic acids, and analyze genomic organization in different organisms. (Understand)

CO2: Describe the mechanisms of DNA replication and repair. (Understand)

CO3: Explain the mechanism of transcription in prokaryotic and eukaryotic cells. (Understand)

CO4: Explain the translation process in prokaryotic and eukaryotic cells. (Understand)

CO5: Differentiate the regulatory mechanisms of transcription and translation process in prokaryotic and eukaryotic cells. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	2	2	3	2	2
CO4	2	2	3	2	2
CO5	2	2	3	2	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Nucleic acids

History and scope of molecular biology. Discovery of DNA, evidence for DNA as the genetic material. Nucleic acids- types and structural organization-Chirality and stability of DNA, triple helix of DNA, Hoogsteen base pairing, G-tetraplex, Different forms of DNA, DNA denaturation and renaturation, hypochromicity, T_m. Cot curve, C- value paradox. DNA-supercoiling, linking number, satellite DNA, possible functions. The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast, protoplasmic fusion.

Module II (CO 2)

(18 hrs)

DNA replication and DNA Repair

Prokaryotic and eukaryotic DNA replication, mechanism of replication. Enzymes and necessary proteins in DNA replication. Antibiotics which inhibit DNA replication. Telomeres, telomerase and end problem of replication. DNA repair - Mismatch, Base-excision, Nucleotide excision and direct repair. DNA recombination-Homologous, site specific recombination and transposition - Types.

Module III (CO 4)

(18 hrs)

Transcription

Prokaryotic and eukaryotic Transcription-Promoter, enhancer and silencer, RNA polymerases I,II,III, general and specific transcription factors of Pol I, Pol II, and Pol III, regulatory elements of Pol I, Pol II, and Pol III. Transcription termination. Post transcriptional modification- 5' cap formation, 3' end processing and polyadenylation, splicing, editing, nuclear export of mRNA, mRNA stability.

Module IV (CO 4)

(18 hrs)

Translation

Genetic code, wobble hypothesis, Prokaryotic and eukaryotic translation. Translational machinery, Mechanism of initiation, elongation and termination in prokaryotes and comparing the events.

Module V (CO 5)

(18 hrs)

Gene Regulation

Regulation of gene expression in *E. coli*, Catabolite repression, Trp operon in *E. coli*, repression and attenuation, Ara operon in *E. coli*, positive and negative controls, Riboswitches. General introduction to gene regulation in eukaryotes at the level of chromatin structure, transcriptional - Transcription activators, co-activators and repressors, Activation and repression of transcription, post transcriptional, translational and post translational levels, methods to identify post translational modification: RNA editing, RNA interference (RNAi).

References

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2014). (6th Edition).
2. *Molecular Biology of the Gene*.
3. Clark, D.P. (2010). *Molecular Biology*. Elsevier Publishers, London.
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10. Snustad, D.P. & Simmons, M.J. (2019). *Principles of Genetics*. John Wiley and Sons.
11. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. (2017). *Molecular Biology of the Gene*. (7th Edition). Pearson.

SEMESTER IV

ELECTIVE BUNCH A – MOLECULAR BIOLOGY

ZO4E02TM25 - MOLECULAR IMMUNOLOGY

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Classify immunity types, immune cells to organs and antigen recognition. (Understand)

CO2: Differentiate different complement system and antigen-antibody interactions in immunity.
(Understand)

CO3: Explain MHC and various transplantation immunology. (Understand)

CO4: Explain immune effector mechanisms and hypersensitivity in immunity. (Understand)

CO5: Describe the various types of immunity in health and immunodeficiency diseases.
(Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	2
CO2	2	2	3	1	2
CO3	2	2	3	1	2
CO4	2	2	3	1	2
CO5	2	2	3	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Types of Immunity

Innate and Acquired immunity; Innate basic immunity - Physical, Physiological defenses, Inflammatory response and Phagocytic system. Acquired Immunity-natural, artificial, active and passive immunity; Humoral and Cell mediated immunity.

Cells of the immune system

Haematopoiesis- B-cell and T-cell maturation and differentiation, Haematopoietic growth factors, B- Cell receptors, T-Cell receptors, Toll-like receptors.

Organs and tissues of the Immune system

Primary and Secondary Lymphoid organs, Thymus, Bone marrow; Lymph node, Spleen and Tonsils, MALT, GALT.

Immunogenicity and Antigenicity

Factors that influence immunogenicity, Haptens, Adjuvants, Epitopes. Properties of B-cell and T-cell epitopes, Immunoglobulins-structure, classes and functions. Antigenic determinants of immunoglobulin – Isotype, Allotype, Idiotype. Immunoglobulin genes- Multigene organization. Generation of antibody diversity. Monoclonal antibodies and clinical uses. Antibody engineering.

Module II (CO 2)

(18 hrs)

Complement System

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

Antigen –Antibody Interactions

Strength of antigen-antibody interaction- antibody affinity and avidity. Types of antigen-antibody reactions - Cross-reaction, Precipitation, Agglutination, Complement fixation. Immunological.

Techniques - Immunoprecipitation. Immunofluorescence. Flow cytometry and fluorescence. Immunoelectron microscopy. Radio-allergosorbent Test (RAST). ELISA and RIA, Western Blotting.

Module III (CO 3)

(18 hrs)

Major Histocompatibility Complex

General organization and inheritance of MHC. MHC 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. Biological significance of MHC. HLA typing, Antigen processing and presentation. MHC and Graft rejection.

Transplantation immunology

Immunologic basis of graft rejection and prevention. Clinical manifestation of graft rejection. General and specific immunosuppressive therapy, Clinical transplantation.

Module IV (CO 4)

(18 hrs)

Immune Effector Mechanisms

Types of Inflammation- acute and chronic. Chemokines. Role of cytokines in immune system. Properties and functions of Cytokines. Cytokine antagonists. Therapeutic uses of cytokines. Role of lymphokines in immune regulation.

Hypersensitivity

Types of Hypersensitivity- IgE- mediated (Type I) hypersensitivity. Antibody- mediated cytotoxic (Type II) hypersensitivity. Immune complex- mediated (Type III) hypersensitivity. Delayed type (Type IV) hypersensitivity. Stimulatory (Type V) hypersensitivity

Module V (CO 5)

(18 hrs)

Immunity in Health and Disease

Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD). Acquired Immunodeficiency Disease (AIDS). Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Vaccines – Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, DNA vaccines. Synthetic peptide vaccines, Multivalent subunit vaccines.

References

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (1994). *Cellular and molecular immunology*. Elsevier Health Sciences.
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8. Helen Chappel & n Mased Harney (2006). *Essentials of Clinical Immunology* (5th edn) Blackwell.
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SEMESTER IV
ELECTIVE BUNCH A – MOLECULAR BIOLOGY
ZO4E03TM25 – CANCER BIOLOGY

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Summarize different cancer cell growth, types, nomenclature and epidemiology.

(Understand)

CO2: Explain cancer metabolism, tumour markers, oncogenes, and signal transduction.

(Understand)

CO3: Summarize the various cancer stages, causes and control. (Understand)

CO4: Describe cell cycle regulation, tumour suppressor genes, telomerase, metastasis, and apoptosis in cancer. (Understand)

CO5: Explain cancer screening and therapies (Understand).

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	1	2
CO2	2	2	3	1	2
CO3	2	2	3	1	2
CO4	2	2	3	1	2
CO5	2	2	3	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Introduction

Growth characteristics of cancer cells; Morphological and ultra-structural properties of cancer cells. Types of growth – hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumors. Epidemiology of cancer.

Module II (CO 2)

Cancer biology and biochemistry (18 hrs)

Aberrant metabolism during cancer development; Paraneoplastic syndromes; Tumor markers; cellular proto-oncogenes - oncogene activation. Growth factors-EGF, TNF and TGF α & β and growth factor receptors, Signal transduction in cancer – Role of transcription factors

Module III (CO 3)

(18 hrs)

Carcinogenesis

Causes of cancer - radiation and chemical carcinogenesis- stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis -DNA and RNA Viruses and human cancer; Cancer endocrinology. Cancer control and prevention – Lifestyle based prevention strategies and the role of yoga as a supportive therapy for cancer (Brief account on - A clinical study at AIIMS Delhi.

Module IV (CO 4)

(18 hrs)

Cell Cycle

Regulation-Tumor suppressor genes p53, p21, Rb, BRCA1 and BRCA2. Telomeres, Telomerase and Immortality; cell-cell interactions, cell adhesion-invasion and metastasis – VEGF signaling, angiogenesis; Epigenetics-Role of DNA methylation in gene silencing-epigenetic silencing of tumor-suppressor genes; Apoptosis in cancer-how mutations in apoptotic pathway cause cancer.

Module V (CO 5)

(18 hrs)

Strategies of anticancer drug therapy

Cancer Screening methods- Breast cancer, cervical cancer, lung cancer, prostate cancer and stomach cancer. Strategies of anticancer drug therapy – chemotherapy, gene therapy. Immunotherapy – Types, CART T-cell therapy, Side effects. Radiotherapy – External beam radiation therapy and Internal radiation therapy and its side effects. Radiosensitizers, Radioprotector. Stem cells and cancer. Effect of alternative medicines.

References

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SEMESTER IV

ELECTIVE BUNCH A – MOLECULAR BIOLOGY

ZO4E01PM25 - MOLECULAR BIOLOGY AND MOLECULAR IMMUNOLOGY

Total Credits: 4

Total Lecture Hours: 180

Course Outcome

CO1: Describe the principles and procedures of DNA isolation, purification, quantification, electrophoresis, and restriction digestion. (Apply)

CO2: Explain the processes of DNA fragment isolation, competent cell preparation, transformation, recombinant screening, and polymerase chain reaction. (Apply)

CO3: Explain the preparation and analysis of antigens, immunodiffusion techniques, immunoelectrophoresis, polyclonal antibody generation, and IgG purification. (Understand)

CO4: Describe immunological techniques, including ELISA, SDS-PAGE, Western blotting, lymphocyte isolation and separation, blood typing, and the WIDAL test. (Apply)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	3
CO2	2	2	2	3	3
CO3	2	3	3	2	2
CO4	1	1	2	3	3

Syllabus Content

MOLECULAR BIOLOGY (90 hrs)

Module I (CO 1) (45 hrs)

1. Isolation & purification of genomic DNA from bacteria.
2. Quantification of DNA by spectrophotometer.
3. Detection of purity in DNA samples.
4. Isolation & purification of plasmid DNA.

5. Agarose gel electrophoresis of genomic & plasmid DNA.
6. Restriction Digestion of genomic & plasmid DNA.

Module II (CO 2)

(45 hrs)

7. Isolation of DNA fragment from agarose gel.
8. Preparation of competent cells by CaCl₂.
9. Transformation.
10. Screening of recombinants.
11. Polymerase chain reaction.

MOLECULAR IMMUNOLOGY

(90 hrs)

Module III (CO 3)

(45 hrs)

1. Preparation of antigens from microbes.
2. Analyses of Antigens: Double Immunodiffusion.
3. Radial Immunodiffusion.
4. Immunoelectrophoresis (IEP) – Demonstration.
5. Generation of polyclonal antibodies and determination of antibody titer.
6. Purification of IgG from hyper immune serum.

Module IV (CO 4)

(45 hrs)

7. ELISA- Demonstration.
8. Separation of antigens by SDS PAGE.
9. Identification of specific antigens by Western blotting –Demonstration.
10. Isolation of lymphocytes from Blood (PBMC).
11. Separation of T and B lymphocytes.
12. Blood Typing in Man.
13. WIDAL Test.

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.

References

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ELECTIVE BUNCH - B
ENVIRONMENTAL SCIENCE

SEMESTER IV

ELECTIVE BUNCH B – ENVIRONMENT SCIENCE

ZO4E04TM25 – ENVIRONMENTAL SCIENCE: CONCEPTS AND APPROACHES

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Explain the concept of environmental science, ecology and evolution. (Understand)

CO2: Discuss various physical environmental aspects of the biosphere. (Understand)

CO3: Explain the scope of climatology and landscape ecology. (Understand)

CO4: Summarise biodiversity and conservation strategies. (Understand)

CO5: Explain Biological invasion patterns and process of biological attributes. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	1	2
CO5	3	2	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Introduction to Environmental Science

Definition, Principle and Scope of environmental Science- its relation to other sciences.

Earth System and Biosphere

Concept of life and life supporting systems. The origin and structure of earth, primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.

Evolutionary Ecology

Darwin's ecology and evolution, Evolutionary trees, natural selection and environment, molecular evolution, speciation and extinction.

Module II (CO 2)

(18 hrs)

The Physical Environment

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 III (CO 3)

(18 hrs)

Weather and Climate

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 of climate - 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.

Climate of India

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.

Landscape Ecology

Land and Landscape processes; Hierarchy: ecosystems to land units; ecological principles at work with Landscapes; Human dimensions and Land Use in agro-ecosystems, urban

ecosystems, rangelands, riparian and wetland systems, coastal and estuarine systems. 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; case studies on corridor r selection problems.

Module IV (CO 4)

(18 hrs)

Biodiversity and Conservation

Biodiversity-concepts and patterns. 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. CBD, IPRs, National and international programmes for biodiversity conservation. CITES and TRAFFIC. Indian Biodiversity Act 2002 and laws, National Board of Biodiversity, State Board of Biodiversity. Ecosystem people and traditional conservation strategies; People's participation in conservation- PFM, community reserve and People's Biodiversity Register (PBR). Biodiversity Management Committee (BMC). Wildlife values and eco-tourism, wildlife distribution in India, problems in wildlife protection - Policies and programmes. Threatened animals of India.

Module V (CO 5)

(18 hrs)

Biological Invasions

Introduction Elton's hypothesis – Invasion patterns and process 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 Positive utilization Quarantine and EIA of biological invasion.

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SEMESTER IV

ELECTIVE BUNCH B – ENVIRONMENT SCIENCE

ZO4E05TM25 - ENVIRONMENTAL POLLUTION AND TOXICOLOGY

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Explain various types of pollution sources, effects and monitoring methods. (Understand)

CO2: Describe the major sources, effects, health impacts, standards, and treatment methods of water pollution. (Understand)

CO3: Describe the sources, impacts, control of soil pollution and solid waste management techniques. (Understand)

CO4: Explain the sources, effects, control of noise, thermal, oil, and radiation pollution. (Understand)

CO5: Explain the toxic effects, exposure, testing, and biomonitoring of pollution in the environment. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	1	2
CO5	3	2	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Introduction

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.

Air Pollution

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, CO₂, CO, NO_x, SO₂, H₂S, oxidants, ozone and hydrogen fluoride. Control of gaseous emission: adsorption by liquids, adsorption by solids, combustion and condensation.

Control of SO₂, NO_x, CO, CO₂ and hydrocarbons.

Module II (CO 2)

(18 hrs)

Water Pollution

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 III (CO 3)

(18 hrs)

Soil Pollution

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.

Solid Waste Management

Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems-composting, vermicomposting, Biodigesters (Biogas plants), incineration, pyrolysis, plasma pyrolysis, sanitary landfills and open dumping yards. Management of plastic and e-waste. Better management strategies (any two model case studies). Treatment process for unsegregated waste, fixation of hazardous solid waste prior to disposal, hazardous waste in landfills.

Hazardous waste (Management and Handling) Rules 1989 - the Manufacture Storage and Import of Hazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998 - Plastic Act 1999. Extended producer responsibility.

Module IV (CO 4)

(18 hrs)

Noise, Thermal and Oil Pollution

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).

Radiation Pollution

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 V (CO 5)

(18 hrs)

Toxicology

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

Dose – Response relationships – Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC50; Margin of safety; Toxicity curves; Cumulative toxicity and LD50 and CTF. Toxic chemicals in the Environment – Biochemical aspects of As, Cd, Pb, Hg, Cu, O₃, PAN, pesticides, MIC and other carcinogens. Bioaccumulation and biomagnification. Occupational toxicology- hazardous chemicals, disorders from chemical exposure at work, assessment of occupational hazards. Toxicity testing; Bioassay – Definition, purpose, criteria

for selection of test organism, methodology, estimation of LC50, Limitation and importance of bioassay, acute toxicity (single), sub-acute toxicity, chronic toxicity, teratogenicity, carcinogenicity and mutagenicity. Bio-monitoring of toxic chemicals - objectives, programs and parameters, concepts of bio indicators. Bio-transformation of Xenobiotics (Selective Toxicity).

References

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SEMESTER IV

ELECTIVE BUNCH B – ENVIRONMENT SCIENCE

ZO4E06TM25 - ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Explain the basic principles and concept of environmental management. (Understand)

CO2: Explain various management practices for ecosystems. (Understand)

CO3: Discuss the environmental impact assessment based on various methods and policies. (Understand)

CO4: Explain Principles and concepts of Remote Sensing and GIS. (Understand)

CO5: Summarize strategies for management and conservation of environment for sustaining life on earth. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	3	2	2	1	2
CO3	3	2	2	1	2
CO4	3	2	2	1	2
CO5	3	2	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Environmental Management

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, SEA, 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, 14001 and 26001; OHSAS 18001.

Module II (CO 2)

(18 hrs)

Ecosystem Management

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. Eco restoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management.

Module III (CO 3)

(18 hrs)

Environmental Impact Assessment (EIA)

Introduction- Definition, history, aim, principles, concept and scope. Baseline data collection, Methods and steps - Adhoc method, checklist method, matrices, Map overlays method, network method, index method. Impact assessment and impact evaluation-EIA Processes, Stages, EIA Statement Environment management plan- Risk assessment and disaster management programme. National Policy on EIA and Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; Environmental Clearance Process in India; Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial, thermal power, nuclear power and multipurpose river valley projects; Central and state pollution control boards for environmental protection. EIA case studies. Life Cycle Assessment (LCA) and its significance.

Module IV (CO 4)

(18 hrs)

Remote Sensing and GIS*

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 (CO 5)

(18 hrs)

Environment Vs Development

Dominance of Man on earth. Limits of growth. Industrial revolution and resource utilization, environmental consequences. Modern agriculture and green Revolution- environmental impacts. Conflicts of interest - environment and development. Tragedy of the commons.

Sustainable Development

Our common future and the idea of Sustainable Development - concepts and dimensions. Basic needs- Imperatives relating to sustainable development. Johannesburg Conference 2002 and follow up Conference on sustainable development. Securing Sustainable futures Millennium Development Goals and Strategies (MDG & S); the earth charter; need and scope for evolving participatory, community based environmental management strategies. Education for sustainability. Building sustainable societies and lifestyles. Ecological Foot Print analysis and its significance. Environmental concerns in traditional societies, Gandhian environmentalism.

* **Note:** Students and faculty can avail of the facility RS & GIS Division of School of Environmental Sciences of the MG University for technical support and guidance for Module IV.

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Web Resources:

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

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

www.unep.org

SEMESTER IV

ELECTIVE BUNCH B – ENVIRONMENT SCIENCE

ZO4E02PM25 - ENVIRONMENTAL SCIENCE

Total Credits: 4

Total Lecture Hours: 180

Course Outcome

CO1: Describe soil properties and nutrient composition across different sites. (Understand)

CO2: Examine water quality and toxicity in various aquatic systems. (Apply)

CO3: Interpret biodiversity patterns using species diversity indices. (Apply)

CO4: Examine pollution effects through histopathology and microbial testing. (Apply)

CO5: Explain Strategies for management and conservation of environment sustainable earth.
(Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	2
CO2	2	1	1	2	3
CO3	2	1	1	2	3
CO4	2	1	1	2	3
CO5	3	2	2	1	2

Syllabus Content

ENVIRONMENTAL SCIENCE I

Module I (CO1)

(45 hrs)

1. Soil texture using micrometry from two different sites.
2. Determination of moisture content.
3. Determination of soil pH from at least three different locations and correlate it with the soil type.
4. Determination of Chloride, Calcium, Magnesium, Potassium and Phosphorous.
5. 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).

6. Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results.
7. Compare the results of Dark and Light bottle method and Chlorophyll method.
8. 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, and evenness.

Module II (CO2)

(45 hrs)

1. Soil texture using micrometry from two different sites.
2. Determination of moisture content.
3. Determination of soil pH from at least three different locations and correlate it with the soil type.
4. Determination of Chloride, Calcium, Magnesium, Potassium and Phosphorous.
5. 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).
6. Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results.
7. Compare the results of Dark and Light bottle method and Chlorophyll method.
8. Identification of trophic levels from gut analysis (Fish or insect).
9. Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices (*This can be done as part of the three / four day field study compulsory for this elective*).

ENVIRONMENTAL SCIENCE II

Module III (CO3)

(45 hrs)

1. Water Quality Analysis:
2. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica.
3. Determination of total dissolved salts (TDS).
4. Toxicity Analysis of Water: For Chlorine, H₂S, Ammonia, Copper and Chromium.
5. Estimation of BOD and COD of polluted water.

6. Determination of LC50 for fish (pesticide) using Probit analysis (use of appropriate software is suggested to find out the value).
7. 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).

Module IV (CO4)

(45 hrs)

1. Isolation and Enumeration of microorganisms in soil (TBC or TMC).
2. Bacteriological quality testing of water and wastewater.
 - (a). Presumptive coliform test
 - (b). Confirmatory coliform test
3. **Field Study Report:** (Three /four days).
4. 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, day-wise itinerary, methodology, results and references. Include photographs of the activity.
5. Group and individual assignments shall be preferred.
(*The activity suggested in Practical-1 can be clubbed with this field study*).

References

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ELECTIVE BUNCH – C
FISHERY SCIENCE

SEMESTER IV
ELECTIVE BUNCH C – FISHERY SCIENCE
ZO4E07TM25 – ICHTHYOLOGY

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Explain Fish taxonomy, evolution, distribution, locomotion, and colouration.

(Understand)

CO2: Discuss on fish feeding, digestion, circulation, and immunity. (Understand)

CO3: Explain fish respiration, excretion, endocrinology, and reproduction. (Understand)

CO4: Describe the fish nervous system, senses, communication, and special adaptations.

(Understand)

CO5: Explain fish adaptations, behavior, diseases, and treatments. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2
CO2	3	3	2	1	2
CO3	3	3	2	1	2
CO4	3	3	2	1	2
CO5	3	3	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Taxonomy, Evolution and Distribution

Origin and evolution of fishes, Classical taxonomy – morphometrics, meristics. Methods employed in phylogenetic studies and fish identification, fish barcoding. Classification upto orders. Biogeographical distribution of fishes.

Body Form and Locomotion

Body shape, body musculature. Swimming and non-swimming locomotion and buoyancy regulation - propulsive systems, hydrodynamic analyses, swimming modes, fish bio-modelling,

bioenergetics, strategies for buoyancy regulation. Fins- types, structure, modifications and functions. Theories of origin of median and paired fins. Integument and Exoskeleton. Colouration - chromatophore pigments and colouration. Physiology of colour change.

Module II (CO 2)

(18 hrs)

Food and Feeding

Structure of alimentary canal. Food, feeding habits and adaptations. Physiology of digestion and absorption.

Blood Vascular System and Defense Mechanisms

Circulatory system - modifications in blood circulation in relation to air breathing. Defense mechanism- immune system, cells and tissues of the fish immune system, modulators of fish immune responses, humoral and cell mediated immune defense, fish antibody molecules and their effector functions

Module III (CO 3)

(18 hrs)

Respiratory System

Gill structure and Physiology of gill respiration. Accessory respiratory organs and mechanism of air breathing in fishes. Swim bladder, structure and function. Weberian ossicle.

Excretory System

Structure and functions of kidney. Nitrogenous products and patterns of their excretion.

Endocrine System and Reproduction

Functions of the endocrine organs and tissues-Pituitary, Thyroid, Gonad, Adrenals, Corpuscles of stannous, Endocrine pancreas, Ultimobranchial. Sexuality, hermaphroditism, (gonochorism), Modes of reproduction- oviparity, aplacental viviparity and placental viviparity. Reproductive cycles and Breeding behaviour. Nest building and parental care. Hormonal and environmental regulation of reproduction.

Module IV (CO 4)

(18 hrs)

Nervous System, Sense Organs and specialized characters

Structure and functions of central and peripheral nervous systems. Structure and functions of sense organs-visual, chemoreception, statoacoustic, mechanoreceptors, thermoreceptors, and electroreceptors. Sound production and detection, Acoustic communication. Electric organs, Luminescent organs, Venomous fishes.

Module V (CO 5)

(18 hrs)

Ecology of Fishes & Fish Pathology

Adaptations to special conditions of life – deep sea, cave, hill-stream fishes. Aestivation and hibernation. Migrations and orientation. Homing and territorial recognition. Schooling. Fish diseases and their causes. Viral diseases. Bacterial infections. Fungal infections. Protozoan diseases. Helminth parasite infections. Crustacean parasite infections. Ulcers and tumours. Prophylactic and therapeutic measures.

References

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SEMESTER IV

ELECTIVE BUNCH C – FISHERY SCIENCE

ZO4E08TM25 - FISHERY RESOURCES AND MANAGEMENT

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Explain Inland fishery resources and diversity. (Understand)

CO2: Describe the Inland fishery management, challenges, and conservation. (Understand)

CO3: Interpret marine fishery resources, oceanography, and productivity. (Understand)

CO4: Explain the climatic impacts on fisheries, marine biodiversity, and conservation. (Understand)

CO5: Summarise Remote sensing, GIS applications, and fisheries planning. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2
CO2	3	3	2	1	2
CO3	3	3	2	1	2
CO4	3	3	2	1	2
CO5	3	3	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Inland Fishery Resources

Freshwater and brackish water fishery resources – Pond, Lakes, Tanks, Estuaries, brackish water lagoons, wetlands and mangroves. Major riverine fisheries in India. Peninsular rivers and its fishery diversity with special reference to endemic species in Kerala. Reservoir fisheries – classification of reservoirs. Methods of enhancement of productivity. Reservoir fisheries of Kerala. Estuarine fisheries – Status and potential of estuarine fisheries, Backwaters of Kerala. Scope of Inland fisheries in Kerala.

Module II (CO 2)

(18 hrs)

Problems and Management of Inland Fishery

Approaches to management of Inland fisheries resources for sustainable development – Activities of FIRMA and Matsyafed. Management challenges of riverine fisheries and fishes. Management of estuarine fisheries. Biodiversity and Management of inland waters with special reference to Vembanad lake and Sasthamkotta lake. Mangrove ecosystem – Degradation and its problems on coastal fisheries. Invasive species and its effect on fish diseases. Derelict water bodies – problems and management aspects. Protection and restoration of fish movements – different types of fish passes and enhancement of fish migration. Effects of dams on riverine fisheries. Sand mining and its impact on fisheries.

Module III (CO 3)

(18 hrs)

Marine Fishery Resources and Oceanography

Coastal Resources: coastal biological resources - finfish, shellfish, seaweeds, sea rasses. Ecological subdivisions of the sea-continental shelf, continental slope, ocean base. Physicochemical properties of sea water-salinity, pH, temperature, light penetration, pressure, dissolved gases, minerals, nutrients and their cycles. Plankton and productivity. Mud banks - formation and significance. Exclusive Economic Zone (EEZ). Indian Antarctica expedition.

Module IV (CO 4)

(18 hrs)

Climatic Factors and Fishery

Critically important climatic factors (temperature, rainfall and wind pattern / monsoon influencing aquatic (inland and marine) productivity and production. Remotely sensed SST, Chlorophyll and Wind pattern features of Indian seas used in locating Potential Fish Zones (PFZ). Influence of rainfall intensity, its seasonal and annual variations on fish migration, breeding.

Marine Biodiversity and Conservation

Marine biodiversity and its threats. Endangered Species, IUCN, Criteria, Red Data Book. Coral Reefs and their sustainability and conservation. Conservation and Restoration of marine protected areas- Marine parks. Coastal Tourism.

Module V (CO 5)

(18 hrs)

Remote Sensing and GIS for Fisheries Management

Basic terms and Concepts - Electromagnetic radiation and its properties, atmospheric

interactions, target interactions. Sensor platforms – boats, balloons, air-crafts and satellites, Sensor systems – global acquisition systems and sequential acquisition system. Environmental satellites – The Landsat series, NOAA & IRS; Digital image processing and interpretation; Elements of GIS, Application of remote sensing and GIS to fisheries and aquaculture planning and development. Study of satellite information, interpretation of Satellite pictures for resource management, case studies in remote sensing and GIS application.

References

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SEMESTER IV

ELECTIVE BUNCH C – FISHERY SCIENCE

ZO4E09TM25 – FISHERY TECHNOLOGY

Total Credits: 4

Total Lecture Hours: 90

Course Outcome

CO1: Discuss the global fisheries, fishing methods, technology, and monitoring. (Understand)

CO2: Explain freshwater aquaculture, fish breeding, nutrition, and management. (Understand)

CO3: Explain sustainable aquaculture practices, mariculture methods, and economic viability. (Understand)

CO4: Describe methods in fish preservation, byproducts, quality control, and export prospects. (Understand)

CO5: Explain statistics, population dynamics, and stock assessment in fisheries. (Understand)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2
CO2	3	3	2	1	2
CO3	3	3	2	1	2
CO4	3	3	2	1	2
CO5	3	3	2	1	2

Syllabus Content

Module I (CO 1)

(18 hrs)

Introduction & Methods of Fishing

Major Fishing nations of the world, Major fishing regions.

Crafts and gears used for fishing in inland and marine waters. Gears–Types of gears-design, operation and efficiency. Destructive and prohibited fishing practices. Recent advances in fishing methods. Fishing using electricity, light. Bycatch reduction devices: Definition, types of bycatch reduction devices and the principles of operation. Fish finders (echo sounders and sonar) and their use. Turtle Excluder Devices: Definition, Types of TEDs. Advanced

communication Systems – VHF, SSB, Inmarsat system. Vessel Monitoring Systems (VMS): Importance, uses, role in fisheries management. Satellite navigation system: GPS: Components of GPS, working, functions, hand held GPS, important applications of GPS in fisheries and aquaculture. Fishing harbours: Classification, facilities, layout of a typical fishing harbour.

Module II (CO 2)

(18 hrs)

Freshwater Culture Fisheries

Methods of culture and cultivable fishes (Carps, Catfishes, Murrels, Prawn). Fish food organisms (Algae, Artemia, Zooplankton). Induced breeding of fishes through hypophysation with special reference to Indian major carps. Management of freshwater fish farm - survey of site, layout, soil, water quality requirements. Soil and water quality management in aquaculture. Pond Fertilization-different kinds of fertilizers and manures, Bio-fertilizers, use of treated sewage for pond fertilization. Aquatic weed management. Algal bloom control, Eutrophication, Waste water treatment practices. Role of microorganisms in fish production, microbial load and algal blooms.

Fish seed collection and Preservation technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes. - transport of eggs, fry, fingerlings and adults.

Nutrition of aquatic animals - nutritional requirements of commercially important finfish and shellfish, dietary requirements of larvae and brooders, feed types, manufacture and ingredients, use of attractants and growth stimulants in fish feeds, alternative protein sources in aquaculture diets, feeding techniques, role of probiotics in nutrition.

Role of genetics in aquaculture– gynogenesis, androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity.

Methods of culture of Indian major carps (Rohu, Catla and Mrigla), exotic carps (common carp, grass carp and silver carp) and Tilapia. Culture of air breathing fishes (*Heteropneustes fossilis*, *Clarius batrachus*, *Channa* spp, and *Anabas testudineus*). Sewage – fed culture of carps, Tilapia and air breathing fishes. Integrated fish culture (Paddy – cum-fish, fish –cum-duck and fish-cum pig). Composite fish culture.

Module III (CO 3)

(18 hrs)

Sustainable Aquaculture

Present scenario and problems: Trends in global and Indian aquaculture; Different farming systems; intensive systems and constraints. Environmental degradation and disease outbreaks. Organic farming; integrated farming; responsible aquaculture; rotational aquaculture; bioremediation; role of biotechnology. Economic viability: export vs. domestic marketing, value addition.

Brackish water Culture and Mariculture

Methods of culture of Mugilids, *Chanoschanos*, milk fish, mullets, crabs, shrimps. Methods of prawn culture- Traditional (Bheries, Pokkali), modern. Culture of pearl oyster, edible oyster and sea mussels.

Module IV (CO 4)

(18 hrs)

Preservation and Fishery Byproducts

Post-mortem change and rigor mortis in fish. Assessment of freshness in fish-physical, chemical and microbial evaluation of freshness. Fish spoilage- bacterial and chemical. Fish preservation- handling and cleaning of fresh fish, chilling, freezing, quick freezing, use of chemicals and antibiotics, irradiation, salting, drying, freeze drying, smoking, canning and pickling. Traditional fishery by-products- fish meal and fish oil preparation and uses. Processing wastes- prawn heads, chitin, Chitosan, Fish protein concentrate (FPC) preparation and Uses of shells, isinglass, glue, guano, fins and leathers. Packaging, storage and transport of fish products.

Quality Control in Processing Industry and Fishery Export

Quality factors of food, tests for quality. Plant sanitation and hygiene. Standards for quality of by-products- Indian and international. Water analysis. Inspection system. Prospects for augmenting fishery exports.

Module V (CO 5)

(18 hrs)

Fisheries Education (Self-study)

Objectives and functions of Institutes: Central Institute of Fisheries Education (CIFE, Bombay), Central Inland Capture Fisheries Research Institute (Barrackpore), Central Marine Fisheries Research Institute (CMFRI, Kochi), Central Institute of Fisheries, Nautical and Engineering Training (CIFNET, Kochi), Central Institute of fisheries Technology (CIFT, Kochi), National

Institute of oceanography (NIO, Dona Paula and Kochi).

Statistical Methods

Fisheries statistics-scope and objectives. Fish population-population structure and estimation. Population dynamics, recruitment. Stock assessments. Estimation of yield and optimum yield. Length- weight relationship.

Aquarium Management

Aquaria and their uses. Setting up and maintenance of an aquarium. Ornamental fishes. Setting up of marine aquaria. Selection of compatible species, breeding of aquarium fishes.

References

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- Wageningen, C.M. (2008). *Fishponds in Farming Systems*. Academic Publishers, Netherlands.

SEMESTER IV
ELECTIVE BUNCH C – FISHERY SCIENCE
ZO4E03PM25 - FISHERY BIOLOGY

Total Credits: 4

Total Lecture Hours: 180

Course Outcome

CO1: Explain anatomical, physiological, and pathological characteristics of various fish species. (Understand)

CO2: Classify fish and crustaceans based on morphometric, meristic, and taxonomic features. (Understand)

CO3: Employ fishery biology aspects, including feeding habits, age determination, reproductive indices, and induced breeding techniques. (Apply)

CO4: Examine fish spoilage, and aquaculture practices through fieldwork and laboratory investigations. (Apply)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	2
CO2	3	3	2	1	2
CO3	2	2	1	2	3
CO4	2	2	1	2	3

Syllabus Content

FISHERY BIOLOGY I

Module I (CO1)

(55 hrs)

1. Study of anatomy of a teleost (Cat fish/Carp). External features and gills.
2. Dissection and display of Viscera, Digestive system, urinogenital system. Branchial blood vessels. Brain and cranial nerves. Dissection of swim bladder, weberian ossicles. Skeleton-skull and vertebrae.
3. Dissection of air-breathing organs and their blood supply of *Anabas*, *Clarius*, *Saccobranchnus* and *Channa*.

4. Study of the anatomy of elasmobranchs. Dissection of branchial blood vessels. Brain and cranial nerves.
5. Dissection of internal ear. Preparation of stained mounts of Ampulla of Lorenzini, otolith, scales and gill filaments.
6. Determination of the rate of ammonia and urea excretion in fish.
7. Determination of the haemoglobin content in fish blood.
8. Identification of blood cells of a teleost.
9. Study of the effect of epinephrine, NaCl and KCl on fish chromatophores
10. Identification of common external and internal parasites of fish.
11. Identification of any 4 fish diseases.

Module II (CO2)

(35 hrs)

1. Study of distinguishing features (morphometric and meristic).
2. Identification and classifications of at least 20 species (5 marine, both bony and cartilaginous, 5 fresh water, 5 cultivable, 5 aquarium fishes) using manuals.
3. Identification and classification of distinguishing features of commercially important crustaceans (3 prawns).

FISHERY BIOLOGY II

Module III (CO3)

(45 hrs)

1. Study of feeding habits of fish through qualitative and quantitative analysis of gut contents of herbivore, carnivore and omnivore species.
2. Study of the scale, vertebra and otolith for determination of age.
3. Determination of gonadosomatic index.
4. Estimation of fecundity.
5. Measurement of ova diameter.
6. Length-weight relationship.
7. Study of the principal stages in the life history of prawn.
8. Methodology of induced breeding of fish through hypophysation.
9. Dissection, collection and preservation of pituitary gland.
10. Preparation of pituitary extract.
11. Dosage and technique of injecting pituitary extract (demonstration).

12. Estimation of total protein and identification of amino acids in fish muscle (two directional chromatography).
13. Extraction and estimation of liver and body oil from commercially important fishes.
14. Fishing crafts and gears-identification of various components of a mechanized fishing craft from actual specimen/model/drawing.
15. Study of principal types of fishing gears from actual specimen/model/drawing.
16. Identification of fishing gearmaterials: twines, ropes, floats, sinkers, buoys and anchors. Identification of fishery by-products.
17. Collection and identification of aquatic weeds and aquatic insects.
18. Formulation and preparation of artificial fish food for Indian major carps and Prawns.

Module IV (CO4)

(45 hrs)

1. Estimation of Trimethylamine
2. Field work and study tour:
A three to four days tour to study various fishery activities at selected centres/sites; visit to a fish seed production farm. Freshwater/Brackish water aquaculture. Fishing operations, fish landing, packing, and transport.
3. Fish preservation and processing chain. Boat building yard and net-making plant. NIO, CIFT, CIFNET, CIMFRI, *etc.* Report the study conducted and submit a 10-page write-up/print-out giving the dates, day-wise itinerary, methodology, results and references. Include photographs of the activity.
4. Group and individual assignments shall be preferred.
5. Each student should submit a collection of 15 Fishes/Crustaceans (5 Freshwater, 5 Marine, 5 Aquarium fishes).

References

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SEMESTER IV
ZO4PRM25 - PROJECT/DISSERTATION

Total Credits: 5

Course Outcome

CO1: Apply fundamental and advanced molecular biology techniques to investigate specific biological problems. (Apply)

CO2: Implement standard protocols and troubleshooting strategies in designing and conducting experiments. (Apply)

CO3: Integrate theoretical knowledge and practical skills to conduct independent research and interpret findings. (Apply)

CO4: Employ bioinformatics and statistical tools and databases to analyze data and validate experimental results. (Apply)

CO5: Communicate research findings effectively through scientific writing and oral presentation during viva voce. (Apply)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	3
CO2	2	2	2	3	3
CO3	2	2	2	3	3
CO4	2	2	2	3	3
CO5	2	2	2	3	3

SEMESTER IV
ZO4VM25 - VIVA VOCE

Total Credits: 2

Course Outcome

CO1: Demonstrate an understanding of fundamental and advanced concepts across various disciplines of zoology through oral examination. (Understand)

CO2: Interpret experimental results and theoretical knowledge acquired during the programme in a coherent and scientifically valid manner. (Understand)

CO3: Explain the relevance and applications of zoological knowledge in addressing biological and environmental problems. (Apply)

Mapping of Course Outcomes with Program Specific Outcomes

Mapping	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	2	2	2	3	3