SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcome based Curriculum Framework

(LOCF)

For

M.Sc. II Zoology

[Spl. Oceanography]

Postgraduate Programme

From

Academic year

2023-24

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Zoology

Undergraduate and Postgraduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Vikrant Deshmukh	Chairman	K J Somaiya college of science and commerce
Subject Expert nominated by Vice-Chancellor			
1	Dr. Meghana Talpade	Associate Professor	Mithibai College, vileParle
Research Scientist- Member			
1	Dr. Ashok Jaiswar	Principal Scientist	CIFE, Mumbai
2	Dr. Sabyasachi sautya	Scientist and Assistant Professor	CSIR-NIO, Mumbai
Subject experts			
1	Dr. Arshad Ali Haider	Assistant Professor	Maharashtra College, Mumbai Central
2	Dr. Vaishali Somane	Associate Professor	MD College, Parel
Representative from Industry/corporate sector/allied area			
1	Mr. Amit Sharma	Deputy Technical Manager	Ultratech Environmental Consultancy and Laboratory, Thane
Meritorious Alumnus			
1	Ms. Roshni Yadav	MSc Oceanography 2018-19	K J Somaiya college of Science and Commerce

Faculty of the specialisation			
1	Dr. Amol Patwardhan	Assistant Professor	K J Somaiya college of science and commerce
2	Ms. Shreya Patil	Assistant Professor	K J Somaiya college of science and commerce
3	Dr. Shanti Upadhye	Assistant Professor	K J Somaiya college of science and commerce
4	Ms. Chetana Kanekar	Assistant Professor	K J Somaiya college of science and commerce
5	Ms. Madhuri Padaya	Assistant Professor	K J Somaiya college of science and commerce
6	Ms. Roshni Yadav	Assistant Professor	K J Somaiya college of science and commerce
7	Ms. Meghna Verma	Assistant Professor	K J Somaiya college of science and commerce
8	Ms. Divya Sarang	Assistant Professor	K J Somaiya college of science and commerce
9	Mr. Rishiraj Duggal	Assistant Professor	K J Somaiya college of science and commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

An Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This has ensured the attainment of the learning outcomes enlisted in

the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty and supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal

Acknowledgement

Syllabus Revision is an essential part of academic sustenance. This year, with the implementation of NEP 2020, we now have the added responsibility of delivering a curriculum that focuses on both- a sound knowledge base along with higher order skills that will support all round development and vocation of the learner. At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also deeply obliged to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am indebted to my young and vibrant colleagues in the Department of Zoology for their sincere and painstaking efforts during the compilation of the restructured syllabus as per NEP 2020 guidelines.

Dr. Vikrant Deshmukh
Chairperson
Board of Studies in Zoology

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Preamble

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. We endeavour to mould young minds to participate, contribute and add value to every milestone in their path towards academic excellence. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum manifold.

The LOCF will assist teachers to envisage the outcome expected from the learners at the end of the programme. It will help them to strategize their teaching effectively. At the same time, this document will guide the students through the new curriculum and help them acquire all the skills and knowledge sets required for their personal and academic growth. Higher education qualifications such as the Master's degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year postgraduate degree Programme,

establishing multidisciplinary education and research universities, pooled credit banks and creating a National research Foundation to promote and support research activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to developing an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

1. Introduction

The M.Sc. Zoology programme is developed by keeping in mind the interest of learners to explore and achieve in depth knowledge and skills in the field of Zoology. The flexible framework helps to maintain the ethos of Zoology degree programmes through periodic programme review within a broad framework of agreed/expected post graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The M.Sc. programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of student's learning levels. Updating teaching, learning pedagogy and outcome-based education form the pillars of the programme.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intends to empower graduates with the skills required for pursuing wildlife-related careers, higher education in Zoology and its allied subjects.

Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning, etc. While designing this framework, an important aspect considered was the measurable teaching-learning outcome to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, NPTEL, SWAYAM and other e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and also of the rest of the world;

Every course is designed in such a way that students get decent exposure to each topic by keeping an equilibrium between these topics and thus creating interest to pursue further education in the field of Zoology. It covers the fundamental concepts of Zoology to establish a strong foundation of the subject and helps students to explore the subject more. Topics varying from Taxonomy, Phylogeny, Genetics, Cellular pathways, Diseases, Ecology, Animal Behaviour, Environment, Conservation, Biotechnology & its applications, Biostatistics etc are taught. Our chosen area of Specialisation is Oceanography. Hence the curriculum includes various aspects of physical , chemical and biological oceanography. Subjects having enormous vocational and research scope such as marine ecology, planktonology, marine pollution are also covered.

The practical sessions are designed to help the students gain necessary skills in biochemical analysis, media preparations, fish identification, chromatography, as well as water analysis. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work and

On-the Job training in the curriculum instills team building attitude within students and ensures the building of a strong industry interface. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation. The Research project or Dissertation helps the students greatly to improve their understanding of the subject and apply their knowledge to the field.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for M.Sc. Zoology will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of M.Sc. Zoology

The M.Sc. Zoology programme is of two years duration. Each year is divided into two semesters. The post graduate program in Zoology is designed to include both classical core topics from basic branches like Taxonomy, phylogeny, anatomy, evolution etc. along with applied branches such as genetics, biotechnology and biostatistics as well as specialisation topics like Chemical oceanography, Microbial oceanography, Marine Biotechnology etc. The Zoology programme thus strikes a perfect balance between fundamental and advanced concepts. The scope of each topic varies with the nature of the specific branch. In our endeavour to improve the employability of the post graduates of the Oceanography program, the curriculum offers courses on entrepreneurial skills in Zoology and its allied fields as well.

The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video tools and other teaching aids can be used as and when required. Wherever possible RBPT approach will be adopted to make the process of learning more learner-centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Programme Education Objectives (PEOs)

The overall aims of Master's degree program in Zoology are to:

1. Elucidate core knowledge and skills in Zoology.

2. Create a sound academia-industry interface.

3. Develop technical skills in Oceanography and gain knowledge of research methodologies and skills of problem solving methods.

4. Provide skills to carry out internship programme and research projects to develop scientific skills

5. Apply the obtained scientific knowledge to address relevant research problems of global importance.

6. Pursue higher studies such as a doctoral degree, or appear for national eligibility test (NET)/(SET) state eligibility test or select any other professional career related to Zoology.

7. Display traits of global citizenship, empathy for all life forms and sustainability.

3. Graduate Attributes in Zoology

Attributes expected from the graduates of M.Sc. Zoology Programme are:

GA-1. Disciplinary knowledge: A deep understanding of the diversity of animals from the evolutionary, functional, and ecological perspective

GA-2. Scientific reasoning: Developing Skills specific to the study of animals such as making observations, generating and presenting data, experimental design, statistical analysis, writing reports, identifying species, mounting specimens, using microscopes and interpreting classification keys.

GA-3. Analytical reasoning: An appreciation of the uniqueness of Indian biodiversity and wildlife and to develop the ability to analyse, think, plan, execute and review this knowledge.

GA-4. Research-related skills: An awareness of the importance of research to the development of the discipline of Zoology and the curiosity to practice the same.

GA-5. Self-directed learning: An understanding of the gaps or deficits in the current knowledge and an attempt to fill those gaps. Entrepreneurial skills as an offshoot of interaction with several Industry experts and monetize the acquired knowledge.

GA-6. Communication Skills: Expertise in all forms of written, spoken, scientific and presentation skills. Personal skills in written and oral communication, analysis, problem solving and decision making.

GA-7. Leadership readiness/qualities: Curiosity, creativity and the ability to learn and to work both independently and effectively as part of a team. Gain life skills such as team work, leadership, patience as a result of group project participation.

4. Qualification descriptors

Upon successful completion of the programme, students receive a Master's degree in Zoology. M.Sc. Zoology graduates of this department acquire knowledge pertaining to various core and applied branches under Zoology along with the development of Practical skills in their specialisation. The postgraduates are expected to demonstrate the extensive knowledge of various concepts in Zoology and their applications. The postgraduates are thus able to contribute to research and development, Academia, Government and public sectors. This programme will establish a solid foundation for the student to pursue further studies in Zoology such as Doctoral work or field based research in the subject.

The list below provides a synoptic overview of possible career paths provided by an postgraduate training in Zoology:

1. Academics
2. Research
3. Eco tourism
4. Pharmaceutical Industry
5. Life science-based Industries
6. Food quality monitoring and packaging technology
7. Environmental monitoring and Analysis
8. Wildlife Photography
9. Wildlife Journalism
10. Animal Behaviour Psychology
11. Medical Laboratory Technology
12. Clinical Research Institutes
13. Entrepreneurship (Apiculture, Aquaculture, etc.)

14. Government service [IFS}

Job Roles for M.Sc. Zoology postgraduate:

After graduation one can seek a professional career as:

1. Academicians
2. Researchers
3. Forest Officer /Ranger
4. Eco tourism facilitators
5. Medical Representatives
6. Technicians in Industries/Laboratories
7. Officers/ Managers in Environmental monitoring, Quality Control and Packaging Technology
8. Wildlife Photographers
9. Wildlife Journalists
10. Animal Behaviour Psychologists
11. Entrepreneurs
12. Clinical Researchers
13. Data Analysts

Higher Education options for M.Sc. Zoology postgraduate:

1. PhD in their respective specializations
2. Clinical Research
3. Medical coding

The learners who complete two years of full-time study of the postgraduate programme of study will be awarded a Master's degree in zoology.

5. Programme Specific Outcomes (PSOs)

After the successful completion of modules in different courses of M.Sc. Zoology, the learner will be able to:

PSO I. Elucidate on basic concepts of taxonomy, physiology, ecology, applied Zoology, developmental biology, genetics, Evolutionary biology, Biotechnology and instrumentation.

PSO II. Demonstrate various practical performance skills.

PSO III. Describe modern concepts of Oceanography, microbial Oceanography, Oceanographic instruments,mineral resources found in the sea.

PSO IV. Explain concepts of General, Physical, Chemical and Biological Oceanography, marine biodeterioration, Planktonology, Fisheries Science, Fish Immunology

PSO V. Develop technical skills in oceanography, marine biotechnology, biostatistics, Advanced in vitro techniques in marine cultures

PSO VI. Analyse anthropogenic effect on marine environment

PSO VII. Demonstrate research aptitude and ability to draft a research proposal for Dissertation

PSO VIII. Develop skills for scientific writing, effective presentation and communication .

5.1 Course Mapping

Semester	PSO / Course		I	II	III	IV	V	VI	VII	VIII
I	MJ I		√	√						
	MJ II		√	√						
	MJ III		√	√						
	MJ IV		√	√						
	Any One	DSEI DSEII DSE III		√	√	√	√			
	RM			-					√	√
II	MJ I		√	√						
	MJ II		√	√						
	MJ III		√	√						
	MJ IV		√	√						
	Any One	DSE I DSE II DSE III		√	√	√	√			
	OJT			√					√	√
III	MJ I		√	√	√	√	√			
	MJ II		√	√	√	√	√			
	MJ III		√	√	√	√	√			
	MJ IV		√	√	√	√	√			
	Any Two	DSE I	√	√			√		√	
		DSE II	√	√			√		√	
		DSE III								

IV	MJ I	√	√	√	√	√			
	MJ II	√	√	√	√	√			
	MJ III	√	√	√	√	√			
	MJ IV	√	√	√	√	√			
	RIA		√	√	√	√		√	√

6. Structure of M.Sc. Zoology programme

The programme consists of two years (two semesters per year). The syllabus is drafted such that all significant theoretical subjects are covered in the initial three semesters with an emphasis on on-the-job training and research project/ internship/ apprenticeship work in industry or certified laboratories.

Sem	Major	DSE	RM/OJT/ RIA	Total
1	14	4	RM 4	22
2	14	4	OJT 4	22
3	16	6	-	22
4	8	-	RIA 14	22

RM : Research Methodology Course

RIA: Research Project/ Internship/Apprenticeship

OJT: On Job Training.

• In semester I, the learner will have four major core courses on General zoology, one discipline specific elective and one common minor course on Research Methodology .

• In Semester II, the learner will have four major core courses on Advanced zoology, one discipline specific elective and will have to engage in an on-the-job training for 21 days.

• In Semester III the subject specialisation begins, the learner has four courses in Oceanography and two discipline specific elective courses

• In Semester IV the learner has four courses in Oceanography, and will have to complete one long Research Project and submit a dissertation at the end of the semester.

• Dissertation should be appreciable, original and of good quality. Assessment of dissertation will be based on an open viva for defense.

1. **Major Core Courses (MJ):**

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

b) There are sixteen Major Core courses (MJ), four each, in semesters I II, III and IV

c) Each Major Core Courses is compulsory.

d) Each Major Core Course consists of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit per practical of two hours per week per course in every semester.

e) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. **Discipline Specific Elective (DSE) :**

a) A course is chosen by the candidate from the same stream as an elective out of the three courses offered. Elective course helps the student to gain a broader understanding of the specialization in the major discipline.

b) There is one DSE course each in semester I, II and two in semester III. The credits assigned are 2 credits for theory ie. 30 hours; 2 lectures of 1 hr each per week and 2 credits for practical of four hours per week in semester 1 and 2. In semester 3, there are 2 credits for theory per course and 1 credit each for the practical.

3. **Research Methodology (RM)**

a) This is a mandatory Minor that all post graduate students of Science have to take.

b) Students are required to achieve understanding of the various nuances of research, how to formulate a research problem, plan the work and execute it effectively. Scientific writing and other skills relevant to research are taught here.

c) This course carries 4 credits (60 - hours in class teaching)

4. **On Job Training (OJT)**

a) On Job training or Internships are introduced as per the guidelines of the National Education Policy (NEP) 2020, which emphasizes the importance of research and internships in postgraduate education. The internships will be mandatory for students in three-year and four-year degree programs, with a duration of 60 to 120 hours.

b) This seeks to equip students with the ability to gain relevant soft skills such as teamwork, problem-solving, work ethics, adaptability, communication, and time management.
c) This training carries 4 credits. 1 credit corresponds to 30 hours of engagement in a semester.

5. Internship (INT):

a) One of the fundamental principles guiding the development of our education system as per NEP 2020 is the fostering of 'outstanding research as a corequisite for outstanding education and development'. with this perspective Research project / Dissertation is a mandatory component of the masters program
b) Here the learner is assigned a research problem related to their field of specialization either within the department or at a premier institute of the country. The learner has to complete their research and present their dissertation at the end of the period.
c) Internship is introduced in semester IV of M.Sc course, having 14 credits. 1 credit of internship corresponds to 30 hours of engagement in a semester.

6.1 Course Content

Sr. No	Semester	Course number	Course Code	Course title
1	I	MJ I	23PSIZOMJIPIV	Phylogeny of Invertebrates and Vertebrates
2		MJ II	23PSIZOMJ2BMM	Biomolecules and Metabolism
3		MJ III	23PSIZOMJ3EDB	Evolution and Developmental Biology
4		MJ IV	23PSIZOMJ4INT	Instrumentation
5		MJ P	23PSIZOMJPI 23PSIZOMJP2	Practicals based on MJI and MJ2 Practicals based on MJ3 and MJ4
6		DSE1 DSE2 DSE3 **[opt any one]**	23PSIZODSE1PCO	Physical and Chemical Oceanography
7			23PSIZODSE2ENT	Insect Classification and Diversity
8			23PSIZODSE3ATS	Animal type Study
9		DSEP	23PSIZODSEPI 23PSIZODSEP2 23PSIZODSEP3	Practical based on the DSE course

10		RM	24PS1ZORM	Research Methodology
11	II	MJ I	23PS2ZOMJIIBT	Industrial Biotechnology
12		MJ II	23PS2ZOMJ2ABE	Animal behaviour and Behavioral Ecology
13		MJ III	23PS2ZOMJ3HUD	Human diseases
14		MJ IV	23PS2ZOMJ4BHT	Biostatistics- basic concepts and hypothesis testing
15		MJ P	23PS2ZOMJP1 23PS2ZOMJP2	Practicals based on MJ1 and MJ2 Practicals based on MJ3 and MJ4
16		DSE 1 DSE 2 DSE 3 **[opt any one]**	23PS2ZODSE1BOM	Biological Oceanography and Marine microbiology
17			23PS2ZODSE2TIC	Entomology- type animal and Insect Control
18			23PS2ZODSE3MOB	Model organisms in Biological research
19		DSE P	23PS2ZODSEP1 23PS2ZODSEP2 23PS2ZODSEP3	Practicals based on each DSE course
20		OJT	23PS2ZOOJT	On Job Training

21	III	MJ I	24PS3ZOMJITEI	Ocean Topography, Ocean Expeditions, and Instruments
22		MJ II	24PS3ZOMJ2ORM	Ocean Resources and Marine Biogeochemical Processes
23		MJ III	24PS3ZOMJ3FPF	Fish Physiology and Fishery Science
24		MJ IV	24PS3ZOMJ4ABT	Aquaculture and Biotechnology
25		MJ P	24PS3ZOMJPI 24PS3ZOMJP2	Practicals based on MJI and MJ2 Practicals based on MJ3 and MJ4
26		DSE [opt any two]	24PS3ZODSEAMB	Animal and Medical Biotechnology
27			24PS3ZODSEGMG	Genome Management and Advanced Genetics
28			24PS3ZODSEIMA	Immunology of Malignancy and Transplant Biology and Animal Tissue culture
29		DSE P	24PS3ZODSEPI 24PS3ZODSEP2 24PS3ZODSEP3	Practicals based on any two DSE courses
30	IV	MJ I	24PS4ZOMJIDSP	Deep sea and polar ecology
31		MJ II	24PS4ZOMJ2LPM	Life processes of Marine microorganisms and Seafood Microbiology

32		MJ III	24PS4ZOMJ3MRB	Marine Biodiversity
33		MJ IV	24PS4ZOMJ4MMP	Marine Meteorology and Marine Pollution
36		RP/INT/A	24PS4ZORIA	ResearchProject/Internship/ Apprenticeship

6.2 Credit distribution for M.Sc. Zoology

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	MJ I	Phylogeny of Invertebrates and Vertebrates	2	1.5	3.5
	MJ II	Biomolecules and Metabolism	2	1.5	3.5
	MJ III	Evolution and Developmental Biology	2	1.5	3.5
	MJ IV	Instrumentation	2	1.5	3.5
	DSE	Student will choose any one DSE	2	2	4
	RM	Research Methodology	4	-	4
	Total				**22**
II	MJ I	Industrial Biotechnology	2	1.5	3.5

	MJ II	Animal behaviour and Behavioral Ecology	2	1.5	3.5
	MJ III	Human diseases	2	1.5	3.5
	MJ IV	Biostatistics- basic concepts and hypothesis testing	2	1.5	3.5
	DSE	Student will choose one DSE	2	2	4
	OJT	On Job Training	4	-	4
	Total				**22**
III	MJ I	Ocean Topography, Ocean Expeditions, and Instruments	2	2	4
	MJ II	Ocean Resources and Marine Biogeochemical Processes	2	2	4
	MJ III	Fish Physiology and Fishery Science	2	2	4
	MJ IV	Aquaculture and Biotechnology	2	2	4
	DSEI	Student will choose 1/3 DSE	2	1	3
	DSEII	Student will choose 1/3 DSE	2	1	3
	Total				**22**

IV	MJ I	Deep sea and polar ecology	2	-	2
	MJ II	Life processes of Marine microorganisms and Seafood Microbiology	2	-	2
	MJ III	Marine Biodiversity	2	-	2
	MJ IV	Marine Meteorology and Marine Pollution	2	-	2
	RIA	Research Project/ Internship/ Apprenticeship	14	-	14
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	DSE [Any one per semester]	Minor Courses	CC
I	Phylogeny of Invertebrates and Vertebrates	Physical and Chemical Oceanography	RM	-
		Insect Classification and Diversity		
	Biomolecules and Metabolism	Animal type Study		
	Evolution and Developmental Biology			
	Instrumentation			
II	Industrial Biotechnology	Biological Oceanography and Marine microbiology	-	OJT
	Animal behaviour and Behavioral Ecology	Entomology- type animal and Insect Control		

	Human diseases	Model organisms in Biological research		
	Biostatistics- basic concepts and hypothesis testing			
III	Ocean Topography, Ocean Expeditions, and Instruments	Animal and Medical Biotechnology	-	
	Ocean Resources and Marine Biogeochemical Processes	Genome Management and Advanced Genetics		
	Fish Physiology and Fishery Science	Immunology of Malignancy and Transplant Biology and Animal Tissue culture		
	Aquaculture and Biotechnology			
IV	Deep sea and polar ecology	-	-	RIA
	Life processes of Marine microorganisms and Seafood Microbiology			
	Marine Biodiversity			
	Marine Meteorology and Marine Pollution			

6.4 Course Learning Objectives

The two year postgraduate Zoology programme is designed to familiarize students with in-depth knowledge of Zoology. The objective of structured syllabus in Zoology is to make the concepts and basics of Zoology clear and interesting to students and also to ensure the development of vertical growth in the subject. The idea behind this is to enable students to develop analytical skills and critical thinking.

It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. our intention is to enable students to formulate cogent arguments, presenting the necessary evidence to establish these, based on a training in Zoology.

7. Detailed M.Sc. Zoology Syllabus

M.Sc. Syllabus with effect from the Academic year 2023–2024

Syllabus - M.Sc I Zoology

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER III									
Core courses THEORY									
I	Ocean Topography, Ocean Expeditions, and Instruments	24PS3ZOMJ1TEI	2	30	2	15	20	30	50
II	Ocean Resources and Marine Biogeochemical Processes	24PS3ZOMJ2ORM	2	30	2	15	20	30	50
III	Fish Physiology and Fishery Science	24PS3ZOMJ3FPF	2	30	2	15	20	30	50
IV	Aquaculture and Biotechnology	24PS3ZOMJ4ABT	2	30	2	15	20	30	50
Core courses PRACTICAL									
	Practicals based on MJ1 and MJ2	24PS1ZOMJP1	4	120	-	-	50		100

	Practicals based on MJ3 and MJ4	24PSIZOMJP2	4	120	-	-	50		100
Discipline Specific Elective DSE [Any two]									
DSE	Animal and Medical Biotechnology	24PS3ZODSEAMB	2	30	2	15	20	30	50
DSE	Genome Management and Advanced Genetics	24PS3ZODSEGMG	2	30	2	15	20	30	50
DSE	Immunology of Malignancy and Transplant Biology and Animal Tissue culture	24PS3ZODSEIMA	2	30	2	15	20	30	50
DSE Practical									
	Practical based on chosen DSE course	24PSIZODSEP1 24PSIZODSEP2 24PSIZODSEP3	2	60	-	25 CIE	25		50
SEMESTER IV									
Core courses THEORY									
I	Deep sea and polar ecology	24PS4ZOMJIDSP	2	30	2	15	20	30	50
II	Life processes of Marine microorganisms and Seafood Microbiology	24PS4ZOMJ2LPM	2	30	2	15	20	30	50
III	Marine Biodiversity	24PS4ZOMJ3MRB	2	30	2	15	20	30	50
IV	Marine Meteorology and Marine Pollution	24PS4ZOMJ4MMP	2	30	2	15	20	30	50

Research Project/ Internship/ apprenticeship									
RIA	Research Project/	24PS2ZORIA							

ZOOLOGY SEMESTER III
Core Course- I
COURSE TITLE: Ocean Topography, Ocean Expeditions, and Instruments
COURSE CODE: 24PS3ZOMJITEI
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Define and describe basic terminology with respect to ocean topography. 2. Discuss on various types of marine sediments 3. Summarise- Ocean expeditions 4. Elaborate on the working of ocean instruments		
Module I	Ocean Topography and Marine Sediments	15L
Learning objectives		

The module is intended to -

1. Give insight to the learner about ocean topography
2. Classify marine sediments

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Identify submarine topography from its properties
2. Elucidate on general properties of sea sediment and relationship among these properties

Subtopic	Title	15L
1.1	Distribution of land, and ocean relief 1.1.1 Ocean Topography: Continental shelf, continental slope, continental rise, trenches 1.1.2 Minor relief feature- Mid ocean ridges, sea mount, submarine canyons, guyots and hydrothermal vents, Wilson cycle 1.1.3 Major relief of ocean basin- Pacific Ocean, Atlantic Ocean, and Indian Ocean	6L
1.2	1.2.1 Composition of Earth: Crust, mantle, core, continental drift. 1.2.2 Seafloor spreading: Pangea Gondwana evolution, paleo-oceanography methods for mapping bottom topography, stratigraphy, paleo-marine fossils	4L
1.3	Marine sediments 1.3.1 Sources and types: Lithogenous, biogenous and cosmogenous sediments, classification of marine sediments based on grain size 1.3.2 Volume and distribution of marine sediments	5L

	1.3.3 Weathering: Types and causes	

Reference:

- Lynne D. Talley, G.L. Pickard, W.J. Emery and James Swift (2011): Descriptive Physical Oceanography: An Introduction- Elsevier (6th edition, 2011).
- Robert H. Stewart (2003): Introduction to Physical Oceanography- online edition (public domain), Aug 2003.
- Alan P. T and Harold V. T. (2014) Essentials of Oceanography, Eleventh Edition 6. Tomczak M. &J.S.Godfrey (2003) Regional Oceanography an Introduction second edition
- Svedrup et al., The Oceans.
- Nair N.B. and Thampi D.H., Atextbook of marine ecology, T-M-H.

Module II	Ocean Expeditions and Instruments	15L

Learning objectives

The module is intended to -

1. Introduce learners to various oceanographic instruments and research vessels
2. Elucidate history of landmark oceanographic expeditions
3. Explain the laws of sea

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Analyse the types of oceanographic instrument based on type of research
2. Describe landmark oceanographic expedition
3. Explain the law of sea

Subtopic	Title	15L
2.1	History of Oceanography: Challenger expedition, International Indian Ocean expedition (IIEO), Monsoon	6L

	experiments in Indian Ocean and World Ocean Circulation Experiment General knowledge of various platforms for oceanographic data collection (RVs, FORV, Remote operation vehicles etc.), Major oceanographic labs and stations of the world and India.	
2.2	The law of sea	2L
2.3	Oceanographic instruments: 1. Grab (Peterson and Van veen) for benthos collection, Naturalist's dredge (Ekman Sanders deep sea anchor dredge), trawl, 2. plankton nets and continuous plankton sampling system, Reversing Nansen bottles, 3. Niskin Water sampler, 4. Reversing thermometer, 5. Salinometer, 6. Secchi disc, 7. Stempel's pipette and dilution jar, 8. CTD, 9. Expendable Bathythermograph (XBT) underwater photography, 10. Remote sensing and satellite imaging, 11. SCUBA apparatus 12. Bottom mounted pressure sensor, 13. Wave recorder system, coastal and ship borne Radar for measuring wave	7L

References:

- Lynne D. Talley, G.L. Pickard, W.J. Emery and James Swift (2011): Descriptive Physical Oceanography: An Introduction- Elsevier (6th edition, 2011).
- Robert H. Stewart (2003): Introduction to Physical Oceanography- online edition (public domain), Aug 2003.
- Open University Course team and Butterworth-Heinemann (1997): Sea water, its composition, properties and behavior; Open University team, 2nd Edition, 1997, jointly published by Oxford,UK, ISBN 0-7506-3715-3

- Alan P. T and Harold V. T. (2014) Essentials of Oceanography, Eleventh Edition 6.Tomczak M. &J.S.Godfrey (2003) Regional Oceanography an Introduction second edition
- Svedrup et al., The Oceans.
- Pickard G.L. and W.J. Emery (1995): Descriptive Physical Oceanography-Pergamon press, (1995 or latest edition).
- Nair N.B. and Thampi D.H., Atextbook of marine ecology, T-M-H.
- Morison, J. H. (1989). Physical oceanography instrumentation for the polar regions: A review. IEEE journal of oceanic engineering, 14(2), 173-185.

Question paper Template
ZOOLOGY SEMESTER III
Core Course- I
COURSE TITLE: Ocean Topography, Ocean Expeditions, and Instruments
COURSE CODE: 24PS3ZOMJITEI
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	5	5	5	-	-	25
II	10	5	5	5	-	-	25
Total marks per question	20	10	10	10	-	-	50
% Weightage	40	20	20	20	-	-	100

ZOOLOGY SEMESTER III
Core Course- II
COURSE TITLE: Ocean Resources and Marine Biogeochemical Processes
COURSE CODE: 24PS3ZOMJ2ORM
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Recognise various ocean resources and their economic importance 2. State conservation and coastal resource management strategies 3. Enlist the characteristics and impacts of oxygen minimum zone on marine life 4. Summarise ocean biogeochemical processes and their relation to Plankton communities and Fisheries		
Module I	**Ocean Resources**	**15L**
Learning objectives The module is intended to - 1. Classify types and distribution of mineral resources from sea 2. Explain the process involved in formation of oil, gas, and sulphur deposits 3. Introduce ONGC and its role 4. Elucidate environmental, scientific, and economical aspect of seabed mining 5. Support coastal and marine resources management		

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Differentiate between types and distribution of mineral resources from sea

2. Discuss on process involved in formation of oil, gas, and sulphur deposits

3. Explain role of ONGC and coastal and marine resources management

5. Elucidate scientific, environmental, and economical aspect of seabed mining

Subunit	Title	15L
1.1	Introduction to Ocean Resources - Overview and History of marine resources	2L
1.2	A. Types of Ocean Resources and its extraction- A) Mineral resources B. Deep sea mud oozes and Polymetallic Nodules (manganese nodules), hydrocarbon extraction., Cobalt crust C. Marine energy resources: – Wave – Tides – Currents – OTEC D. Oil, gas and massive sulphide and role of ONGC.	7L
1.3	Exploration and Uses of Ocean Resources	1L
1.4	Scientific, Economical and Environmental aspects	2L
1.5	Conservation of Ocean Resources	1L
1.6	Legal aspects and policy of ocean natural resources	1L
1.7	Coastal and Marine Resources Management	1L

References:

- The Oceans: Their Physics, Chemistry, and General Biology by H. U. Sverdrup, Martin W. Johnson, Richard H. Fleming; Prentice-Hall of India Pvt.Ltd
- Essentials of oceanography by P. Trujillo Alan, Harold V. Thurman; Prentice-Hall of India Pvt.Ltd
- A Textbook of Marine Ecology – Nair, N.B. & Thumpy, D.H., the Macmillan Book Company of India Ltd Beer, TEnvironmental Oceanography: Second Edition (Marine Science Series), CRC Press, 1997.
- Kennish, M.J., Pollution Impacts on Marine Biotic CommUNITies, CRC Press, New York, 1998.
- Alongi, D.M., Coastal Ecosystem Processes, CRC Press, New York, 1998.
- Eisma, D., Intertidal deposits, River Mouths, Tidal flats and Coastal Lagoons, CRC Press, New York, 1998.

Module II	Marine Biogeochemical Processes	15L

Learning objectives

The module is intended to -

1. Introduce Nutrient Dynamics and Biogeochemical Processes in Ocean
2. State the role of Plankton communities in relation to Ocean Productivity

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Summarise the role of biogeochemical cycles and their impact on marine life
2. Differentiate between plankton communities and their importance in ocean productivity

Subunit	Title	15L
2.1	Introduction to Major and Minor Nutrient Dynamics and Cycling	1L
2.2	A. Organic matter: dissolved, particulate, and colloidal species, sources, classification, composition, Distribution,	2L

	seasonal variations B. Ecological significance, Growth promoting and growth inhibiting effects, Colour Dissolved Organic Matter (CDOM)	
2.3	Biogeochemical cycles with special reference to estuaries	2L
2.4	A. Phytoplankton and primary productivity, pigments, photosynthesis, Net and gross primary productivity, Rate of primary production in inshore and offshore regions of Arabian Sea and Bay of Bengal, B. Latitudinal and Seasonal variations in primary productivity, Factors affecting primary production, methods of estimation, Relationship of phytoplankton productivity to light and nutrients, Role of phytoplankton in global carbon cycle, Impacts of climate change.	4L
2.5	A. Zooplankton communities and secondary production - linkages to higher trophic level, Plankton as indicators of fisheries. B. Benthic ecosystem processes, benthic environment. Organism sediment relations. C. Benthic pelagic coupling	3L
2.6	Monsoon driven biogeochemical processes in the Arabian Sea and Bay of Bengal, Spatial and Temporal variations in the nutrient concentrations.	3L

References:

- John H Simpson and Jonathan Sharples, (2012): Introduction to the Physical and Biological Oceanography of Shelf Seas; Cambridge University Press.
- J. P. Riley & Chester, Introduction to Marine Chemistry, Academic Press London, and New York.
- Carol M. Lalli & Timothy R. Parsons, Biological Oceanography, and Introduction. Elsevier, Butterworth-Heinemann.
- Peter Castro & Michel E. Huber, Marine Biology, The Mc-Grawcompanies.

- Tom Garrison & Robert Ellis (2013), Oceanography: An invitation to Marine Science 9th Edition Cengage Learning.
- Frank J. Millero (2013), Chemical Oceanography (4th Edition) by, CRC Press, Taylor & Francis Group.
- Susan Libes (2009), Introduction to Marine Biogeochemistry (2nd Edition) by Academic Press.
- H. Elderfield(2006) The Oceans and Marine Geochemistry (Ist Edition)by Elsevier.
- Gerry Bearman (2005), Marine biogeochemical cycles (2nd edition) by, The Open University.
- Thomas S. Bianchi (2007), Biogeochemistry of Estuaries by, Oxford University Press.
- Horst D. Schulz Matthias Zabel (2006), Marine Geochemistry (2nd edition) by, Springer.
- Michael E. Q. Pilson (2005), An introduction to the Chemistry of the Sea (2nd Edition) University Press.
- https://wedocs.unep.org/bitstream/handle/20.500.11822/11349/rsocr_printedition.compressed_Part16.pdf?sequence=17&isAllowed=y#:~:text=The%20plankton,Cloern%20and%20others%2C%202014)

Question paper Template
ZOOLOGY SEMESTER III
Core Course- II
COURSE TITLE: Ocean Resources and Marine Biogeochemical Processes
COURSE CODE: 24PS3ZOMJ2ORM

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	5	5	-	-	25
II	5	10	5	5	-	-	25
Total marks per question	10	20	10	10	-	-	50
% Weightage	20	40	20	20	-	-	100

ZOOLOGY SEMESTER III
Core Course- III
COURSE TITLE: Fish Physiology and Fishery Science
COURSE CODE: 24PS3ZOMJ3FPF
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Enlist endocrine glands, their hormones, and functions in fish 2. Describe regulation of various physiological processes in fish 3. Elaborate the commercial significance of various Fishes, Crustaceans and Molluscs. 4. Promote Sustainable Fisheries with respect to Fish Population Dynamics and its Management

Module I	Fish Physiology	15L

Learning objectives

The module is intended to -

1. Introduce learner to various physiological processes in fish
2. Discuss endocrine glands, their hormones and functions in fish

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Enlist endocrine glands, their hormones, and functions in fish
2. Describe regulation of various physiological processes in fish

Subunit	Title	15L

1.1	Physiology of Digestion: Digestive system, digestive enzymes, hormones, and regulation; factors affecting digestion.	2L
1.2	Physiology of Reproduction: Structure and functions of gonads, gonadal steroidogenesis; seasonality of reproduction, and endocrine control of reproduction	2L
1.3	Modes of reproduction: Sex determination and differentiation; sexual dimorphism; primary and secondary sex characters; bisexual reproduction; inter-sexes; hermaphroditism, Sex reversal.	2L
1.4	Reproductive cycle and breeding patterns: Role of environment (photoperiod, temperature, rainfall), Pheromones and reproductive behaviour	2L
1.5	Endocrinology of stress in fish	1L
1.6	Thermoregulation in fish - Response to heat, response to cold	2L
1.7	Physiology of Osmoregulation and Respiration: Excretory and osmoregulatory organs in fish and their functions; Mechanism of osmotic and ionic regulation; Acid base regulation, Mechanism of excretion of nitrogenous waste	2L
1.8	Physiology of pigmentation and colour changes	2L

References:

1. Animal Physiology: Adaptation and Environment- Knut Schmidt-Nielsen · 1997
2. Handbook of Hormones: Comparative Endocrinology Hironori Ando, Kazuyoshi Ukena, Shinji Nagata · 2021

Module II	Fishery Science	15L

Learning objectives

The module is intended to -

1. Elucidate the population dynamics, sustainable catch calculation, fluctuation in fish populations and various fish population models
2. Justify fluctuations in fish population with special reference to climate change
3. Enlist various entrepreneurial possibilities in fishery sector

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Classify fish based on Francis Day and FAO.
2. Present on fishing season, breeding season, general characteristics and economic importance of major commercial fisheries such as Elasmobranchs, teleost, crustacean, and molluscan
3. Introduce learner to population dynamics, sustainable catch calculation, fluctuation in fish populations and various fish population models
4. Interpret entrepreneurial possibilities in fishery sector

Subunit	Title	15L
2.1	An overview of fish classification as per Francis Day and FAO.	1L
2.2	A. Major commercial fisheries Elasmobranchs - shark and ray Teleosts - Sciaenids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Sole fish, Harpodon, Ribbon fish fisheries. B. Crustacean fisheries - Prawns (penaeid and non-penaeid), Shrimps, Lobsters, and Crabs. C. Molluscan fisheries.	4L
2.3	General account on food and feeding habits of fishes and methods of analysis - Qualitative and Quantitative Methods	1L
2.4	Potential Fishing Zones, Sea Surface Temperature variations and Pelagic fisheries, Influence of upwelling on Fishery in Arabian Sea and Fish migrations and Marking and Tagging of fishes.	2L
2.5	A. Population Dynamics Abundance in population and	4L

	Fishery - Pelagic, demersal, and deep-sea fishing, Stock assessment: Collection of basic data; stock size, age composition, length-weight relationship, Biomass, population growth, Population yield models - Maximum Sustainable Yield, Optimum Yield, Overfishing. B. Stock enhancement, strategies like introduction of exotic species, pre and post stocking management, potential risk of stocking.	
2.6	Fishing Regulations and Management technique - licensing, technical control measures such as size limitations, closed fishing areas, closed seasons, size of nets and mesh size regulations, limited entry.	3L

References

- A Text Book of Fishery Science And Indian Fisheries by Dr C B L Srivastava; Kitab Mahal
- Mismanagement of Marine Fisheries by Alan Longhurst; Cambridge publication
- Indian Fish and Fishing by Francis Day; W. Clowes and Sons, 1883
- FAO Species identification sheets for fishery purposes WESTERN INDIAN OCEAN Fishing Area 51, prepared by Fischer, W. and Bianchi, G.
- Marine Resources Service, Fishery Resources and Environment Division FAO Fisheries Department, Rome, Italy.

Question paper Template
ZOOLOGY SEMESTER III
Core Course- III
COURSE TITLE: Fish Physiology and Fishery Science
COURSE CODE: 24PS3ZOMJ3FPF
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	5	5	5	-	-	25
II	10	5	5	5	-	-	25
Total marks per question	20	10	10	10	-	-	50
% Weightage	40	20	20	20	-	-	100

ZOOLOGY SEMESTER III
Core Course- IV
COURSE TITLE: Aquaculture and Biotechnology
COURSE CODE: 24PS3ZOMJ4ABT
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Describe the fish farming systems and techniques 2. Explain the management practices and the recent trends in aquaculture. 3. Elaborate on culturing techniques of marine algae and its applications 4. Describe the objectives and techniques of germplasm preservation, transgenic fishes with examples.

Module I	Aquaculture Techniques	15L

Learning objectives

The module is intended to -

1. Understand the techniques involved in aquaculture practices.
2. Get detailed information about fish diseases and vaccines.
3. Make the learner understand the recent trends in aquaculture.

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Describe all the techniques involved in aquaculture.
2. Elaborate management practices and types of vaccines used in aquaculture.
3. Elucidate recent trends in aquaculture
4. Explain impact of aquaculture on environment

Module 1	Title	15L
1.1	Introduction to aquaculture: 1.1.1. General principles and present status - scope, branches, and importance. 1.1.2 Aquaculture practices in India.-Coastal and Mariculture 1.1.3 Cultivable organisms for aquaculture and criterion for their selection.	1L
1.2	Different farming systems of aquaculture [with reference to Selection of suitable sites and Farm construction, enrichment, stocking, monitoring, harvesting] - 1.2.1 Pond Culture 1.2.2 Cage Culture 1.2.3 Pen Culture 1.2.4 Running Water Aquaculture 1.2.5 Raft Culture 1.2.6 Aqua ranching 1.2.7 Polyculture 1.2.9 Integrated multi trophic aquaculture 1.2.10 Pearl culture	6L
1.3	Seed production through finfish and shellfish hatcheries. 1.3.1 Culture practices of finfish (Rohu,Catla). 1.3.2 Culture practices of Crustaceans (shrimps and prawns), 1.3.3 Culture practices of molluscs (mussels, edible oysters and cephalopods)	3L
1.4	Health Management 1.4.1 Control of predators, parasites, and diseases. 1.4.2. Vaccines in aquaculture - types of vaccines and its application. Routes of vaccine administration (oral, injection, immersion vaccination)	2L

1.5	Recent trends in aquaculture - 1.5.1. Biofloc fish culture 1.5.2 Aquaponic system 1.5.3 Recirculatory Aquaculture System (RAS)	2L
1.6	Aquaculture Industries and Impact of aquaculture on environment	1L

References:

1. Rath, A.K. Freshwater Aquaculture,1 January 2011 ,3rd edition
2. Santhanam, et.al. a Manual of Freshwater Aquaculture
3. Pillay, T.V.R. Aquaculture – Principles and Practices, November 2011, 2nd Edition
4. Burnell, G. and Allan, G. "New technologies in aquaculture - Improving production efficiency, quality and environmental management". CRC Press, 2009.
5. Handbook of fisheries and aquaculture. Indian Council of Agricultural Research.
6. MPEDA 1990. Aquaculture Engineering and Water Quality Management. Cochin, India
7. https://dof.gov.in/sites/default/files/2020-07/Aquaponics_System.pdf
8. https://vikaspedia.in/agriculture/fisheries/fish-production/culture-fisheries/types-of-aquaculture/recirculatory-aquaculture-system-ras

Module II	Applications of Biotechnology in Aquaculture	15L

Learning objectives

The module is intended to -

1. Make the learner aware of the practices and techniques involved in marine biotechnology
2. Familiarise them with protozoan and metazoan cultures aiding in developing genetically modified fishes
3. Make the learner understand the need for preserving fish germplasm
4. Illustrate the learner the concept of transgenic fishes, genetic engineering with examples

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Discuss various strategies practices to conserve fish germplasm
2. Explain transgenic fish technology with examples
3. Elucidate the culturing methodologies for organisms such as microalgae, fungi, protozoans, microscopic metazoans

Module II	Title	15L
2.1	Microalgae culturing techniques. Bioreactor designs for microalgae culturing	2L
2.2	Pathogenic Protists - Importance, culturing techniques, Applications in marine biotechnology	2L
2.3	Chromosomal manipulation - haploidy, triploidy, tetraploidy, androgenesis, gynogenesis Inbreeding - mechanism and significance	3L
2.4	Cell line development of Shrimp and Fish Media preparation for culturing, growth requirements, gill culture	2L
2.5	Fish antifreeze technology	2L
2.6	Germplasm Preservation	1L
2.7	Gene manipulation for strain development in fish, Transgenic fish - Genetic Engineering in Fish (AquaBounty Salmon, GFP from jellyfishes, Rainbow trout)	3L

References

1. https://www.frontiersin.org/articles/10.3389/fmars.2022.864165/full
2. http://eprints.cmfri.org.in/9713/1/G.Gopakumar.pdf
3. https://www.intechopen.com/chapters/45962
4. https://www.sciencedirect.com/science/article/abs/pii/S0044848621007006

5. https://www.researchgate.net/publication/358940127_Marine_Fungi
6. https://link.springer.com/content/pdf/10.1023/A:1008823515157.pdf
7. https://www.frontiersin.org/articles/10.3389/fmars.2021.629629/full
8. https://www.mdpi.com/1660-3397/15/2/27
9. Fish Genetics and Aquaculture Biotechnology, Editors; T J Pandian, C.A. Strüssmann, M.P. Marian , 2005
10. Aquaculture and Biotechnology - Latife Ceyda IRKIN

Question paper Template
ZOOLOGY SEMESTER III
Core Course- IV
COURSE TITLE: Aquaculture and Biotechnology
COURSE CODE: 24PS3ZOMJ4ABT
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5	-	25
II	5	5	5	5	5	-	25
Total marks per question	10	10	10	10	10	-	50
% Weightage	20	20	20	20	20	-	100

ZOOLOGY SEMESTER III
Discipline Specific Elective DSE-I
COURSE TITLE: Animal and Medical Biotechnology
COURSE CODE: 24PS3ZODSEAMB
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Recall various methods of gene transfer used in animals 2. Enlist the applications of biotechnology in medicine and animal Biology 3. Explain vaccines, their types and production 4. Elaborate on monoclonal antibodies, their production, and applications

Module I	Animal Biotechnology	15L

Learning objectives

The module is intended to -

1.Make the learner familiar to Transgenic animal technology, the procedures and applications with examples.
2. State the role of Conservation biological strategies in species conservation
3. Explain to the learner the significance of regulating transgenesis
4. Make the learner understand recent advances in human therapies based on tissue, engineering, cell adhesion and monoclonal antibodies.

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Schematically describe methods of transgenesis

2. Enumerate examples of various animals created by transgenesis

3. State applications of transgenesis

4. Explain strategies involved in conservation biology

5. Discuss various laws regarding use of transgenic animals

6. Elaborate on advances in tissue engineering

7. Explain the role of monoclonal antibodies in therapeutics

8. Elucidate xenotransplantation as a possible answer to graft- rejection.

Module 1	Title	15L
4.1	Animal Biotechnology 4.1.1 Transgenic animals and their applications: Mice as model system for human diseases and as test case model, Cows, pigs, sheep, goats as biopharming systems. Transgenic insects and birds 4.1.2 Recombinant DNA technology to prevent animal diseases 4.1.3 Conservation Biology-Embryo transfer, cryobanking, frozen zoos. 4.1.4 Regulation of transgenic animals and patenting of genetically engineered animals	10L
4.2	Human therapies 4.2.1 Tissue engineering: Skin, liver, pancreas 4.2.2 Xenotransplantation - Pigs as organ donors 4.2.3 Targeted gene replacement for correcting a mutant Gene- gene therapy	5L

References

- Molecular Biotechnology- Principles and applications of recombinant DNA- B. Glick and J. Pasternak, 3rd edition
- Biochemistry. U. Satyanarayana and U. Chakrapani. 2007. Third edition

Module II	Medical Biotechnology	15L

Learning objectives

The module is intended to -

1. Explain the methodology involved in production of various types of recombinant vaccines
2. Elaborate on the process of monoclonal antibody production and their therapeutic Applications

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Describe types of recombinant vaccines and methodology involved in their production
2. Elucidate the hybridoma technology for monoclonal antibody production
3. List the therapeutic applications of monoclonal antibodies

Module II	Title	15L
2.1	Subunit vaccines 2.1.1 Subunit Vaccine production against viruses- Herpes simplex, Bovine foot & mouth disease virus 2.1.2 Peptide vaccines-synthetic drugs (engineered proteins) 2.1.3 Genetic immunisation - DNA vaccines 2.1.4 Live recombinant vaccines - concept 2.1.4.1 Attenuated vaccines against Cholera, Salmonella sp. 2.1.4.2 Vector vaccines -Vaccine directed against viruses, Rabies virus G-protein, Hepatitis B surface antigen 2.1.5 Anti-idiotypic vaccine for cancer treatment	8L
2.2	Monoclonal antibodies (mAbs) & therapeutic applications: 2.2.1 mAbs for prevention of rejection of transplanted organs 2.2.2 Treatment of bacterial blood infection 2.2.3 Human monoclonal antibodies	7L

	2.2.4 Hybrid human-mouse monoclonal antibodies 2.2.5 HIV therapeutic agents 2.2.6 Anti-tumour antibodies	

References

- Molecular Biotechnology- Principles and applications of recombinant DNA- B. Glick and J. Pasternak, 3rd edition
- Biochemistry. U. Satyanarayana and U. Chakrapani. 2007. Third edition

Question paper Template
ZOOLOGY SEMESTER III
Discipline Specific Elective DSE-I
COURSE TITLE: Animal and Medical Biotechnology
COURSE CODE: 24PS3ZODSEAMB
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5	-	25
II	5	5	5	5	5	-	25
Total marks per question	10	10	10	10	10	-	50
% Weightage	20	20	20	20	20	-	100

ZOOLOGY SEMESTER III
Discipline Specific Elective DSE-II
COURSE TITLE: Genome Management and Advanced Genetics
COURSE CODE: 24PS3ZODSEGMG
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Explain various gene transfer techniques and cloning types and its techniques 2. Elaborate on blotting techniques 3. Discuss Mendelian work on drosophila 4. Describe various mapping techniques and its significance

Module I	Genome Management	15L

Learning objectives

The module is intended to -

1. Enlist the different tools for genetic engineering
2. Discuss different types of gene transfer techniques
3. Describe the different blotting techniques
4. Introduce nucleic acid probes and hybridization
5. Make Learners familiar with concept of Cloning vectors, Retrovirus and SV40 virus and their applications

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Elaborate the different tools for genetic engineering
2. Explain different types of gene transfer techniques
3. Elaborate the different blotting techniques
4. Describe nucleic acid probes and hybridization

5. Explain Cloning vectors, Retrovirus and SV40 virus and their applications		
Subtopic	**Title**	**15L**
1.1	Basic tools of genetic engineering: 1.1.1 Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation, liposome, ligand mediated, gene gun or biolistic approach, viral mediated 1.1.2 Selection and screening of recombinants 1.1.3 Nucleic acid probes and hybridization, Southern blotting and Northern blotting 1.1.4 Immunological assays for identification of gene product, Western-blot	10 L
2.1	2.1.1 Cloning vectors 2.1.2 Retrovirus and SV40 vectors 2.1.3 Special purpose vectors- Expression vectors, Secretion vectors Shuttle or bifunctional vectors, single stranded phage and phagemids	5 L
References: 1. Molecular Biotechnology- Principles and applications of recombinant DNA-B. Glick and J. Pasternak, 3rd edition 2. Biochemistry. U. Satyanarayana and U. Chakrapani. 2007. Third edition 3. Basic Biotechnology. Colin Ratledge. 2006 3rd edition		
Module II	**Advanced Genetics**	**15L**
Learning objectives The module is intended to - 1. Explain Morgan's experiments on Drosophila with respect to linkage 2. Elaborate on various chromosome mapping methods and their applications 3. Explain The lod score method for analysing linkage of human genes 4. Introduce the concept of physical chromosome mapping using different methods		

5. Explain mapping of human diseases
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Describe various chromosome mapping methods and their applications 2. Explain physical chromosome mapping using different methods 3. Elaborate the techniques of mapping human diseases

Subtopic	Title	15L
2.1	Morgan's Experiment with Drosophila	1L
2.2	Gene recombination and role of chromosomal exchange	1L
2.3	Constructing genetic linkage maps of Human Genome 2.3.1 The lod score method for analysing linkage of human genes 2.3.2 Human genetic maps a) Physical chromosome mapping: deletion mapping, cell hybridization mapping, mapping by in situ hybridization; correspondence of and physical maps b) Practical applications of chromosome mapping - tracking the inheritance of an allele with coupled DNA markers	6L
2.4	Genetic linkage maps, Chromosome walking, Chromosome jumping, Restriction mapping	4L
2.5	Positional cloning and its limitations	1L
2.6	Integration of physical and genetic maps	1L
2.7	Mapping human disease Identification of genes causing Mendelian genetic disease and	1L

	complex genetic disease	

References

- iGenetics- A Molecular approach by Peter J.Russell, 3rd edition
- Fairbanks, Daniel J, and William R. Andersen. Genetics: The Continuity of Life. Pacific Grove, CA: Brooks/Cole Pub, 7th edition
- Concepts of Genetics- Klug W.S., Cummings M.R., Spencer C.A. and Palladino M.A. (Pearson Int. Edition).
- Genes XII- Lewin Benjamin (Jones & Bartlett publishers)
- Molecular Cell Biology- Lodish H, Berk A, Kaiser C.A., Krieger M., Scott M.P., Bretscher A., Ploegh H. &Matsudaira P. (W.H. Freeman & Co.)
- Principles of Genetics- Snustad D.P. and Simmons M.J. (John Wiley & sons Inc.)
- Principles of Genetics- Robert H. Tamarin (Tata McGraw-Hill)

Question paper Template
ZOOLOGY SEMESTER III
Discipline Specific Elective DSE-II
COURSE TITLE: Genome Management and Advanced Genetics
COURSE CODE: 24PS3ZODSEGMG

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5	-	25
II	5	5	5	5	5	-	25
Total marks per question	10	10	10	10	10	-	50
% Weightage	20	20	20	20	20	-	100

ZOOLOGY SEMESTER III
Discipline Specific Elective DSE-III
COURSE TITLE: Immunology of Malignancy and Transplant Biology and Animal Tissue culture
COURSE CODE: 24PS3ZODSE3IMA
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. State the role of immune system to surpass the tumour 2. Elaborate the tumour antigen and recent advance in immunotherapy of cancer 3. Explain different concepts of animal cell culture 4. Describe different techniques in primary cell culturing

Module I	Immunology of Malignancy and Transplants	15L

Learning objectives

The module is intended to -

1. Explain the concepts related to immunology of Malignancy
2. Enlist the different immunotherapy of cancer
3. Classify different transplants and its technique

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Differentiate between the cancer and tumours
2. Explain the immune response in malignancy
3. Enlist the different Immunotherapy of cancer
4. Explain the different types of transplants and grafting techniques
5. Elaborate different factors rejecting the grafts

Module 1	Immunology of Malignancy and Transplants	15L
1.1	1.1 Immunology of Malignancy 1.1.2 Introduction- Concept of Immunology, Cancer, Tumour, Malignancy 1.1.3 Tumour antigen 1.1.4 Immune response in malignancy 1.1.5 Immune surveillance 1.1.6 Immunotherapy of cancer	9L
1.2	1.2.1 Classification of Transplants 1.2.2 Allograft rejection 1.2.3 Histocompatibility antigen 1.2.4 Factors favouring allograft survival 1.2.5 Factors favouring allograft survival 1.2.5 Graft vs Host reactions	6L

References

- The Biology of Cancer by Robert Weinberg
- Ananthanarayan and Paniker's Textbook of Microbiology, Eleventh Edition
- Kuby Immunology 8th ed. 2018 Edition - 21 June 2018 ISBN-13: 978-1319114701 ISBN-10: 1319114709

Module II	Animal Tissue culture	15L

Learning objectives

The module is intended to -

1. Introduce the concept of Transformation, immortalisation, and Differentiation, cellular interactions
2. Enlist different types of animal cell and their role in organisms
3. Discuss culturing techniques and primary cell line culture
4. Explain cell differentiation
5. List different methods of cell preservation
6. Elaborate on the applications of animal tissue culture

Learning outcomes

After the successful completion of the module, the learner will be able to

1. Describe concept of Transformation, immortalisation, and Differentiation, cellular interactions
2. Differentiate different types of animal cells
3. Elaborate cell culturing techniques
4. Explain the 3D cell culture
5. Detail information on cell differentiation
6. Interpret the different types of cell preservation
7. Explain the different applications of animal tissue culture

Module II	**Animal Tissue culture**	**15L**
2.1	2.1.1 Different terminologies related to cell culture 2.1.2 Biology of cell culture 2.1.3 Animal cell culture: Histological background 2.1.4 Concept of transformation, immortalisation, differentiation, cellular interactions	4L
2.2	2.2.1 Animal cell types (Epithelial tissue, Connective tissue, muscular tissue and nervous tissue) 2.2.3 Culturing and Sub-Culturing of Animal Cells 2.2.3 Primary Culture and development of cell lines – normal and transformed	4L
2.3	3-D culture: organ culture, histotypic culture, and organotypic culture	2L
2.4	2.4.1 Cell differentiation: Stem cell plasticity, markers of differentiation, induction of differentiation, differentiation and malignancy 2.4.2 Transformation and Immortalization	2L
2.5	Cell line preservation techniques	2L

2.6	Applications of animal tissue culture: vaccines, cell biology, drug testing, medical applications, Stem cells and their applications in medicine and tissue engineering	IL

References

- Freshney, R. I. (2015). Culture of animal cells: a manual of basic technique and specialized applications(6thEdn) John Wiley & Sons.
- Masters, J. R. (2000). Animal cell culture: a practical approach (3rdEdn) Oxford University Press
- Butler, M., 2004. Animal cell culture and technology. Taylor & Francis.
- Clynes, M. (Ed.). (2012). Animal cell culture techniques. Springer Science & Business Media.
- Davis, J. M. (Ed.). (2011). Animal cell culture: essential methods. John Wiley & Sons.
- Animal Cell Culture-Practical Approach: R. W. Jhon (Masters Oxford)
- Biochemistry. U. Satyanarayana and U. Chakrapani. 2007. Third edition
- Methods in Cell Biology (Vol. 57)- Animal Cell Culture Methods: J. P. Mathon and D. Barnes (Eds) (Academic Press).
- Mammalian Cell Biotechnology: A Practical Approach (1991): Butler, M. (IRL Press, Oxford)

Question paper Template
ZOOLOGY SEMESTER III
Discipline Specific Elective DSE-III
COURSE TITLE: Immunology of Malignancy and Transplant Biology and Animal Tissue culture
COURSE CODE: 24PS3ZODSEIMA
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5	-	25
II	5	5	5	5	5	-	25
Total marks per question	10	10	10	10	10	-	50
% Weightage	20	20	20	20	20	-	100

Semester III
Practical
24PS3ZOMJP1
[Major course 1+2]

Course I	General Oceanography, Ocean expeditions and Instruments

Learning objectives

1. Introduce the learner to various Oceanographic Instruments and their applications.
2. Familiarise with composition of marine sediment
3. Demonstrate the collection of marine sediment, plankton and water samples

Learning outcomes

1. Apply practical skills for conducting high quality research.
2. Demonstrate and operate the modern oceanography instruments on board.
3. Recognise various oceanographic instruments and recall its applications.

1) Study of Water sampling Devices:
   a) Mayer's Water Sampler
   b) Knudsen Water sampler
   c) Nansen Water sampler
   d) Universal Water sampler
   e) Horizontal Water sampler
   f) Bacteriological Water sampler
2. Study of Sediment sampling Devices
   a) Ekman's Dredge
   b) Petersen grab
   c) Mud snapper
   d) Vertical Gravity Corer
   e) Ooze Sucker
3. Study of Temperature and depth measuring devices
   a) Towing Surface Thermometer
   b) Six's Maximum and Minimum Thermometer
   c) Reversing Thermometer
   d) Bathythermograph

e) Fortin's Barometer

4. Study of Light measuring devices
   a) Secchi Disc
   b) Lux Meter
5. Study of Current measuring devices
   a) Watt's Current Meter
   b) Direct Reading Current Meter
6. Study of Plankton nets: IO Standard net, Hensen net and Clarke Bumpus net. Stemple pipette and counting slide.
7. Study of telemetry tracking instruments for marine endangered species
8. Photographic documentation of Marine Science related issues. Submission of soft & hard copy of 5 original photographs taken by the learner
9. Interpretation of topographic and bathymetric map
IO. Field visit and Report to any Marine Research Institute

Course II	Ocean Resources and Marine Biogeochemical Processes

Learning objectives

This Practical is intended to

1. Summarise the importance of ocean resources and role of biogeochemical processes in Ocean
2. Detect organic content present in seawater and ocean sediments

Learning outcomes

After the successful completion of the Practical, the learner will be able to

1. Determine organic content in ocean water and in ocean sediments
2. Compare various ocean resources and state their economic importance

1. Estimation of Organic Carbon in Seawater
2. Estimation of Total Organic Content in Ocean Sediments
3. Plotting of Ocean Resources on World Map
4. Identification of Marine Sediments - Types: Biogenous, Lithogenous
5. Identification of Benthic Organisms with the help of Identification Key
6. Study of Ocean Color Monitoring

7. Visit to Marine Industries and Report Writing 8. Identification of ocean minerals https://iopscience.iop.org/article/10.1088/1755-1315/1118/1/012056/pdf#:~:text=The%20content%20of%20organic%20matter%20in%20water%20at%20each%20station,in%20water%20at%20high%20tide

Semester III
Practical
24PS3ZOMJP2
[Major course 3+4]

Course III	Fish Physiology and Fishery Science
Learning objectives This Practical is intended to- 1. Demonstrate measurement and biometric parameters and analysis of correlation between various biometric parameters 2. Explain the identification characteristics of Marine and Freshwater fisheries	
Learning outcomes After the successful completion of the Practical, the learner will be able to 1. Identify difference between Marine and Freshwater Fisheries 2. Measure biometric parameters and analyse correlation between various biometric parameters	
Practical- 1. Morphometric Analysis of Fishes 2. Gut content analysis and method of assessment of feeding 3. Reproductive Biology of Fish - Maturity stages. 4. Estimation of digestive enzyme - amylases	

5. Determination of Age and Growth of fish.
6. Study of fish chromatophores
7. Calculate correlation (standard length and total length, head length and total length, body depth and total length).
8. Identification and classification of Freshwater fishes (Rohu, Catla, Mrigal, Tilapia, Gourami) and Marine water Fishes (Elasmobranchs: shark and ray Teleosts: Sciaenids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Sole fish, Harpodon, Ribbon fish fisheries).
9. Crustacean fishery (Penaeus monodon, P. indicus, M. monoceros, P. stylifera, Solenocera indica, Nematopaleomon, Acetes indicus).
10. Molluscan fishery (Meretrix, Perna viridis, Katelysia sps, Crassostria sps., Xancus pyrum, Solen kempi, Cuttlefish and Gastropods).
11. Study of sense organs- sting apparatus and electric organ in Elasmobranchs, Bioluminescence, lateral lines

Course IV	Aquaculture and Biotechnology

Learning objectives

This practical is intended to make the learner:

1. Demonstrate the use of aquaculture equipment such as nets, tanks, filters.
2. Design and prepare layouts of aquaculture setups
3. Summarise the importance of Aquaculture practices
4. Prepare marine culture media, isolate algae and count the bacterial population

Learning outcomes

After the successful completion of the Practical, the learner will be able to:

1. Analyse the optimum nutritional composition of fishes fit for aquaculture
2. Handle aquaculture instruments and design a hatchery
3. Culture, isolate and count the number of bacterial growth
4. Prepare feed for the growth of fishes

1. Design and layout of fresh water and brackish water farms, fish and shrimp hatcheries
2. Analysis of morphometric characters of fishes
3. Visit to farms and hatchery.
4. Economic survey of fish/shrimp farms.
5. Formulation of organic fertilisers for aquaculture.

6. Preparation of marine culture media 7. Isolation technique of microalgae 8. Identification of Marine microalgae using identification key 9. Enumeration of marine microalgae from given sample 10. Analysing bacterial population in seawater

Semester III

DSE1- Practical

24PS3ZODSEP1

Course DSE I	Animal and Medical Biotechnology
Learning objectives This Practical is intended to 1. Demonstrate basic aseptic skills to the learner 2. Emphasise on the need to maintain asepsis in the Biotechnology laboratory 3. Prepare the student for performing basic microbiological practicals and projects independently	
Learning outcomes After the successful completion of the Practical, the learner will be able to 1. Perform aseptic transfers of cultures 2. Prepare sterile media and glassware for tissue culture 3. Demonstrate various streaking techniques for Bacterial isolation 4. Perform various bacteriological enumeration experiments 5. Use the mini-prep test kit to demonstrate isolation of plasmid DNA	
1. Demonstration of aseptic technique: a. Prepare the work place for aseptic handling, b. Packing glassware (flasks, test tubes, pipettes, petridish) for sterilisation. c. Aseptic transfer of liquids (pipetting from flask to test tube) 2. Preparation of sterile LB agar plate, slant, butt & sterility testing	

3. Demonstration of streaking technique using bacterial culture to obtain isolated colonies (double T, side streak, quadrant streak)
4. Determination of viable cell count in the given culture of bacteria by dilution & spread-plate technique.
5. Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis
6. To estimate the number of bacteria in the given culture by Nephelometry
7. Perform restriction digestion of DNA using kit method
8. Demonstrate and explain western blotting set up
9. Plot a bacterial growth curve and compare between different growth media.
10. Visit to Biotechnology Research lab and prepare a report

Semester III

DSE2- Practical

24PS3ZODSEP2

Course DSE III	Genome Management and Advances in genetics

Learning objectives:

This practical is intended to-

1. Demonstrate of different blotting techniques (Western and Southern blotting)
2. Explain different types of cloning vectors and techniques used in gene transfer
3. Demonstrate calcium phosphate transfection
4. Introduce the concept of linkage, recombination, and gene mapping
5. Interpret human karyotypes
6. Solve problems related to genetic linkage and mapping

Learning outcomes:

After the successful completion of the Practical, the learner will be able to-

1. Perform different blotting techniques
2. Elaborate on different types of cloning vectors and techniques used in gene transfer
3. Perform calcium phosphate transfection using kit
4. Elucidate concept of linkage, recombination and gene mapping
5. Solve the problems based on genetics

Practical:

1. Problems based on restriction mapping of DNA
2. Western Blot analysis from gel/membrane
3. Demonstration of Southern blotting
4. To study the Calcium phosphate transfection to introduce DNA into eukaryotic cell using Kit (source: https://www.sigmaaldrich.com/IN/en/technical-documents/protocol/cell-culture-and-cell-culture-analysis/transfection-and-gene-editing/calcium-phosphate-transfection-kit)
5. Identification of different types of cloning vectors
6. Study of different techniques or advanced techniques used for gene transfer
7. Study of Human karyotypes (Normal and abnormal)
8. Problems based on linkage and recombination

Semester III

DSE3- Practical

24PS3ZODSEP3

Course DSE III	Tumour and Transplant Immunology and ATC

Learning objectives

This practical is intended to-

1. Emphasis on the design and equipments required to set up Animal Tissue Culture lab
2. Identify the normal and abnormal (tumour/ malignant) cells
3. Demonstrate the culturing techniques and media preparations
4. Understand different methods of cell preservation
5. Demonstrate the cell competent

Learning outcomes:

After the successful completion of the Practical, the learner will be able to-

1. Elaborate the design of well equipped animal tissue culture laboratory
2. Differentiate between the normal and abnormal cells
3. Perform the cell culture techniques and prepare the media for animal cell culture
4. Interpret the basic knowledge of different methods of cell preservation

Practical:

1. Design and equipment of cell culture lab, bio-safety, GLP and GMP standards in cell lab.
2. Identification of normal cells and abnormal cells
3. Study of different types of tumours or malignant cell through permanent slides photograph
4. Media requirements - preparation of medium and sterilisation techniques. Advantages and disadvantages of natural and synthetic media.
5. Culture methods – hanging drop, suspension and monolayer culture.
6. Preparation of cells for primary culture- Trypsinization of cells.
7. Methods of cell preservation. Organ culture – clot grid, chorioallantoic and ocular culture.
8. Visit to Animal Tissue Culture laboratory and report writing

ZOOLOGY SEMESTER IV
Core Course- I
COURSE TITLE: Deep sea and polar ecology
COURSE CODE: 24PS4ZOMJIDSP
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Describe deep sea environment 2. Discuss abiotic and biotic factors of deep sea 3. Explain polar environment 4. Elaborate on abiotic and biotic factors of polar region

Module I	Deep sea ecology	15L

Learning objectives

The module is intended to -

1. Explain deep sea environment
2. Discuss abiotic and biotic factors of deep sea

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Discuss deep sea environment
2. Elaborate on abiotic and biotic factors of deep sea

Subtopic	Title	15L
1.1	The twilight zone: characteristics and its faunal diversity	3L

1.2	Deep sea: Floral and faunal diversity	3L
1.3	Physical factors of deep sea: Temperature, light and pressure conditions	2L
1.4	Faunal adaptation to deep sea environment	2L
1.5	Hydrothermal vents and cold seeps	2L
1.6	Chemosynthetic production, energy flow, food web	1L
1.7	Shallow vents and cold seeps	1L
1.8	Massive sulphide communities	1L

References

- Byan Richard. Ocean - Revealing The Secrets of the Deep, Ist edition
- J.J. Bhatt. Oceanography - Exploring the Planet Ocean, Ist edition
- WWF. Atlas of the Oceans, , Ist edition
- Textbook of Marine Ecology. N. Balakrishnan Nair, D. M. Thampy. 1980, Macmillan, Delhi Publication, Textbook of Marine Ecology. N. Balakrishnan Nair, D. M. Thampy. 1980, Macmillan, Delhi Publication

Module II	Polar ecology	15L

Learning objectives

The module is intended to -

1. Explain polar environment
2. Discuss abiotic and biotic factors of polar region
3. Introduce learner to effects of climate change on polar ecology and conservation of wildlife of polar region
4. Elaborate on India's role in polar research

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Discuss polar environment
2. Explain abiotic and biotic factors of polar region
3. Understand effects of climate change on polar ecology and conservation of wildlife of polar region
4. Elaborate on India's role in polar research

Subtopic	Title	15L
2.1	Introduction and physical factors of the polar seas	2L
2.2	Floral and faunal diversity of polar region	3L
2.3	Faunal adaptation for polar region	2L
2.4	Energy flow, food web of polar region	3L
2.5	Climate change and climate variation and their consequences on polar regions	2L
2.6	Conservation and wildlife management in polar regions	2L
2.7	India in Polar expeditions	1L

Reference:

- Byan Richard. Ocean - Revealing The Secrets of the Deep, Ist edition
- J.J. Bhatt. Oceanography - Exploring the Planet Ocean, Ist edition
- WWF. Atlas of the Oceans, , Ist edition

- Textbook of Marine Ecology. N. Balakrishnan Nair, D. M. Thampy. 1980, Macmillan, Delhi Publication, Textbook of Marine Ecology. N. Balakrishnan Nair, D. M. Thampy. 1980, Macmillan, Delhi Publication

Question paper Template
ZOOLOGY SEMESTER IV
Core Course- I
COURSE TITLE: Deep sea and polar ecology
COURSE CODE: 24PS4ZOMJIDSP
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	5	5	5	-	-	25
II	10	5	5	5	-	-	25
Total marks per question	20	10	10	10	-	-	50
% Weightage	40	20	20	20	-	-	100

ZOOLOGY SEMESTER IV
Core Course- II
COURSE TITLE: Life processes of Marine microorganisms and Seafood Microbiology
COURSE CODE: 24PS4ZOMJ2LPM
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Describe the reproduction, food habits and nutrition in fish 2. Compare the culturable and non-culturable marine microorganisms 3. Explain role of microbes in seafood spoilage. 4. Discuss seafood Safety and food laws and regulation.		
Module I	**Life Processes of Marine Microorganisms**	**15L**
Learning objectives The module is intended to - 1. make learners understand the mechanism of nutrition, respiration, reproduction and pathogenicity of marine microorganisms		
Learning outcomes - After the successful completion of the module, the learner will be able to - 1. Explain the mechanism of nutrition, respiration, reproduction and pathogenicity of marine microorganisms 2. Describe the methods to control marine microorganisms.		
Subtopic	**Title**	**15L**

1.1	Marine microbes: An Overview, Qualitative and quantitative distributions of marine microorganisms, Gram-positive, Gram-negative bacteria.	2L
1.2	Asexual and sexual reproduction of bacteria, endospore.	1L
1.3	Growth and Nutrition: Definition of measurement of growth, Kinetics, Nutritional types of microorganisms – Photolithoautotrophs, Photoorganoheterotroph, Chemolithoautotrophs, Chemoorganoheterotrophs.	3L
1.4	Culturable and nonculturable bacteria and their importance.	3L
1.5	Microbial fermentation: Different fermentation pathways – ethanolic, homolactic acid, heterolactic acid, Mixed acid and Butanediol fermentation. Importance of fermentation.	3L
1.6	Microbial pathogenicity: Pathogenic properties of bacteria, toxins and extracellular enzymes, seawater borne human pathogens.	3L

References:

- Talaro, Kathleen P. (2002). Foundations in microbiology. Boston: McGraw-Hill
- John Paul 1999. Marine Microbiology, Elsevier.
- Munn and Munn 1996. Marine Microbiology: Ecology and Applications. BIOS Scientific publisher.
- Kirchman, L Microbial Ecology of the Oceans 2000 John Wiley and Sons. Hans G. Truperet. al 1991.
- Rheinheimer, G., 1980 Aquatic Microbiology-an Ecological Approach. Blackwell, Scientific Publications

Module II	Seafood Microbiology	15L

Learning objectives

1. Understand the incidence of microbes in seafood and their role in seafood spoilage.
2. Understand conventional, modern and rapid methods of detection of microbes and their products in seafood.

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Explain important microorganism groups in seafood.
2. Discuss factors influencing microbial growth.
3. Understand concepts of food Safety, quality management and regulation in the food industry

Subtopic	Title	15L
2.1	Microbes in seafoods - 2.1.1. Important microorganism groups in seafood and their sources	1L
2.2	Factors influencing microbial growth in seafood - 2.2.1. Intrinsic and extrinsic factors 2.2.2. Biofilm formation in foods and assessment 2.2.3 Microbial stress responses in the seafood environment	3L
2.3	Microbial seafood spoilage - 2.3.1 Types of fish spoilage -Autolysis,bacterial and chemical 2.3.2 New spoilage bacteria in refrigerated seafood 2.3.3 Indicators of microbial seafood spoilage	2L
2.4	Microbial foodborne diseases - 2.4.1 Food Borne infections 2.4.2 Food Borne intoxicants 2.4.3 Opportunistic pathogens	4L

	2.4.4 New and emerging food pathogens	
2.5	Control of microbes in seafood - 2.5.1 Control of access of microbes in seafoods 2.5.2 Control by novel processing technology	3L
2.6	Regulation of microbiological quality of seafood and safety- 2.6.1 Quality Control using microbiological criteria 2.62 Food laws and regulation, FSSAI, Codex Alimentarius and other quality standards 2.6.3 Risk Analysis for safe food supply	2L

References:

1. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing, Cambridge, UK.
2. Food processing and preservation, Subbulakshmi G., Udipi S. A., 2006, New Age International, New Delhi.
3. Austin, B. (2006). The bacterial microflora of fish, revised. *TheScientificWorldJournal*, Vol. 6, pp. 931–945. https://doi.org/10.1100/tsw.2006.181
4. https://microbenotes.com/microbial-spoilage-of-fish-preservation/
5. Contamination, M. (2016). Spoilage of Fish and Other Seafoods. *Food Microbiology: Principles into Practice*, 301–306. https://doi.org/10.1002/9781119237860.ch18
6. Doyle, M. P. (2009). *Food Microbiology and Food Safety Series Editor*. Retrieved from http://www.springer.com/series/7131
7. http://ecoursesonline.iasri.res.in/course/view.php?id=438

Question paper Template
ZOOLOGY SEMESTER IV
Core Course- II
COURSE TITLE: Life processes of Marine microorganisms and Seafood Microbiology
COURSE CODE: 24PS4ZOMJ2LPM

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	10	5	-	-	-	25
II	10	10	5	-	-	-	25
Total marks per question	20	20	10	-	-	-	50
% Weightage	40	40	20	-	-	-	100

ZOOLOGY SEMESTER IV
Core Course- III
COURSE TITLE: Marine Biodiversity
COURSE CODE: 24PS4ZOMJ3MRB
[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to - 1. Identify and study the different habitats of the marine environment and related diversity 2. Understand and apply marine laws to protected sites. 3. Discuss origin and evolution of marine mammals 4. Diversify marine mammals in Indian waters and their conservation status		
Module I	**Coastal Diversity of India**	**15L**
Learning objectives The module is intended to - 1. Understand species specificity from east and west coast of India 2. Describe biodiversity components and their relation to ecosystem 3. Grasp knowledge of the Indian Biodiversity Laws		
Learning outcomes After the successful completion of the module, the learner will be able to - 1. Identify the interaction between organisms 2. Identify the habitat based on the morphological adaptations 3. Remember and reproduce legal features pertaining to marine diversity		
Subtopic	**Title**	**15L**

1.1	Coastal habitats of India - An introduction	2L
1.2	Indian mangroves- flora and fauna of mangroves- East and West Coast	4L
1.3	Coral reefs- Andaman & Nicobar, Lakshadweep, Pirotan, Gulf of Mannar	2L
1.4	Faunal diversity of India	3L
1.5	Marine protected areas of India	2L
1.6	Introduction to Biodiversity Conservation Laws of India with respect to marine diversity, Ramsar Convention	2L

References

- Textbook of Marine Ecology. N. Balakrishnan Nair, D. M. Thampy. 1980, Macmillan, Delhi Publication
- https://wiienvis.nic.in/database/mpa_8098.aspx
- https://wii.gov.in/images/images/documents/GIZ/Reference.pdf
- http://eprints.cmfri.org.in/10433/1/29_Laxmilatha_1.pdf
- https://nopr.niscpr.res.in/bitstream/123456789/4271/1/IJMS%2032(3)%202 26-233.pdf
- https://nopr.niscpr.res.in/bitstream/123456789/4271/1/IJMS%2032(3)%202 26-233.pdf
- https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=1cc237 13ea1421a7e891a871fcd1422545e20389
- https://portals.iucn.org/library/sites/library/files/documents/2011-055.pdf

Module II	Marine Mammalogy	15L

Learning objectives

The module is intended to -

1. Make the learner aware of the diversity, adaptation, and classification of marine mammals
2. Discuss the distinguishing characteristics, ancestors of modern marine mammals and their ecological role
3. Illustrate the association of marine mammals with humans and threat to the population

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Discuss marine mammal biology, diversity and classification in Cetaceans, Pinnipeds, Sirenians.
2. Compare characters, analogy and homology with terrestrial mammals
3. Understand the evolution, behaviour, and threats to marine mammals

Subtopic	Title	15L
2.1	Marine and Terrestrial mammals - Differences, similarities, and affinities	2L
2.2	Evolution of marine mammals: 2.2.1 Origin of marine mammals 2.2.2 Evolution of marine mammals 2.2.3 Diversity of marine mammals	3L
2.3	2.3.1 Cetaceans - classification, adaptation, diversity, social behaviour and migration	4L

	2.3.2 Cetaceans in the Indian waters	
2.4	Pinnipeds - classification, adaptation, diversity, social behaviour	2L
2.5	Sirenians - classification, adaptation, diversity, social behaviour	2L
2.6	Ecological role, association with humans and threats	2L

References

- Marine Mammals - Evolutionary Biology. Annalisa Berta, Third Edition
- Marine Mammals of the World. FAO Identification Guide
- Marine mammals. Sutaria, Dipani & Arthur, Rohan & Sathasivam, Kumaran. (2015). Edition 1. Universities Press (India) Private Limited
- Marine mammals of the world - Systematics and Distribution. Dale W Rice, (1998) Fourth Edition.

Question paper Template
ZOOLOGY SEMESTER IV
Core Course- III
COURSE TITLE: Marine Biodiversity
COURSE CODE: 24PS4ZOMJ3MRB
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	5	5	5	-	-	25
II	10	5	5	5	-	-	25
Total marks per question	20	10	10	10	-	-	50
% Weightage	40	20	20	20	-	-	100

ZOOLOGY SEMESTER IV
Core Course- IV
COURSE TITLE: Marine Meteorology and Marine Pollution
COURSE CODE: 24PS4ZOMJ4MMP
[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Explain basic measurements of marine meteorology and weather forecasting. 2. Describe dynamics of Indian monsoon and concept of climate change 3. Understand the hazardous effects of pollutants on the marine ecosystem 4. Elaborate on the global and national laws regulating prevention of marine pollution and describe the importance, process, and types of Impact Assessments

Module I	Marine Meteorology and Climate Change	15L

Learning objectives

The module is intended to -

1. Recite the theoretical basis for weather phenomena, the use of numerical models to forecast the development of weather systems,
2. Describe atmospheric motion, rainfall pattern and climate change.

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Describe the principles of measurement of standard atmospheric instrumentation for pressure, air temperature, humidity, wind and precipitation
2. Develop hypotheses and measurement strategies for field work in meteorology and oceanography

Subtopic	Title	15L
1.1	Basic measurements of meteorological oceanographic parameters - 1.1.1 Air pressure 1.1.2 Temperature 1.1.3 Wind 1.1.4 Moisture	1L
1.2	High and low pressure systems and fronts 1.2.1 Air Masses and movement of air masses 1.2.2 Fronts - Warm ,cold ,occluded and stationary fronts	3L
1.3	Atmospheric motion - 1.3.1 Basic pattern of air movement, 1.3.2 Factors affecting atmospheric motion, 1.3.3 jet stream	2L
1.4	1.4.1 Formation of clouds and its classification, 1.4.2 Rain pattern	1L
1.5	1.5.1 Weather map, 1.5.2 Weather forecasting and weather code	1L
1.6	Dynamics of Indian Monsoon - 1.6.1 Monsoonal circulation in the Indian Ocean, 1.6.2 Monsoon theories, 1.6.3 Rainfall distribution	3L
1.7	Tropical-Revolving Storms - 1.7.1 Origin, structure and movements, Explosive Cyclogenesis, Cold Fronts, Thunderstorms and fog 1.7.2 Storm warning signs, 1.7.3 Coastal Hazard Management	2L
1.8	1.8.1 Climate change, Concepts in climatology, fundamental	2L

	oceanic processes influencing climate 1.8.2 Effect of global warming on Indian monsoon systems 1.8.3 Effect of El-nino and La-nina on Indian rain pattern	

References:

1. MARINE METEOROLOGY fifth edition- Larry Lawrence

   https://www.dtwd.wa.gov.au/sites/default/files/teachingproducts/MARO46_CCBY.PDF

2. Marine Meteorology -Nutshell series book 2-Capt.H. Subramanium,3rd edition, Vijaya Publication
3. Guide to Meteorological and Oceanographic Instruments. WMO – No. 8
4. Meteorological instruments – Knowles Middleton and Athelstan F. Splihaus
5. Monsoon meteorology by C.S. Ramage,1971 Academic Press, New York, 296 p.
6. Jet stream meteorology by E.R. Reiter
7. An introduction to Dynamic Meteorology – JR Holton
8. Monsoons – PK Das , 12th edition, 2018

Module II	Marine Pollution and Management	15L

Learning objectives

The module is intended to -

1. Make the learner aware of the types, hazards and remediation of marine pollutants
2. Discuss various national and global laws dealing with protection of marine environment
3. Explain the concept, working and screening of Environmental Impact Assessments and its importance

Learning outcomes

After the successful completion of the module, the learner will be able to -

1. Illustrate threats of various pollutants to the marine environment
2. Discuss Indian and global laws protecting the marine habitats
3. Explain working of EIAs, their types and screening processes

Subtopic	Title	15L
2.1	Marine Pollution- Sources, effects and remediation of - Oil pollution Plastic pollution Radioactive pollution Halogenated hydrocarbon Heavy metal pollution Sewage and solid waste	6L
2.2	Laws and pollution control boards for protection of marine environment MARPOL Convention London Convention Global Programme of Action MPCB CPCB	3L
2.3	Environmental Impact Assessment Evolution of EIA History of EIA in India The EIA process, agencies conducting EIA Forms of impact assessment Comparative review of EIA procedures and practices EIA and SEA	6L

References:

- Ocean - Revealing The Secrets of the Deep by Byan Richard, 2007 Parragon Books Publication, Ist edition
- Oceanography - Exploring the Planet Ocean. J.J. Bhatt. Krieger Publishing Company, Ist edition
- WWF. Atlas of the Oceans, Chartwell Books Publishing , Ist edition
- https://www.nccr.gov.in/sites/default/files/EIA.PDF
- https://www.cseindia.org/understanding-eia-383
- https://www.researchgate.net/publication/344819892_Strategic_Environmental_Assessment_in_India_Trends_and_Prospects
- Nair, N.B. and Thampy. Textbook of Marine Ecology, Ist edition

Question paper Template
ZOOLOGY SEMESTER IV
Core Course- IV
COURSE TITLE: Marine Meteorology and Marine Pollution
COURSE CODE: 24PS4ZOMJ4MMP

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5	-	25
II	5	5	5	5	5	-	25
Total marks per question	10	10	10	10	10	-	50
% Weightage	20	20	20	20	20	-	100

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is

interactive and all sessions between students and teachers are based upon reciprocity and respect.

I) The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate the development of a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).

Each Course 50 M	**Internal-CIE - 20 M**	**External-Sem End - 30 M**
	Seminar 10 M (3 M Viva+ 3 M Presentation Skills+ 4 M PPT and Writeup)	Any 3 out of 4 = 15 M per Module
	Home Assignment 10 M (5 M per Module)	

- The CIE is taken at regular intervals in the form of Seminar presentations, MCQ based tests, Paper Summary writing etc.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hours

  End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	5 M x 5 Q = 25 M	3 M x 5 Q = 15 M
2	II	5 M x 5 Q = 25 M	3 M x 5 Q = 15 M

Each question will have six sub questions a, b, c, d, e, f and out of which any three should be answered.

Evaluation pattern: Practical

Each Course 75 M	**Internal-CIE - 25 M**	**External-Sem End - 50M** P1 + P2 = 50 M (25 M + 25 M) P3 +P4 =50 M (25 M + 25 M)
	Test P1 + P2 = 10 M (5 M + 5 M)	P1 - (Journal - 5 M + Viva - 5 M + Experiment 15 M = 25 M)
	Performance Based P1 + P2 =15 M (7M + 8 M)	

- Continuous Assessment for 25 Marks [P1+P2}throughout the entire semester.
- 50 Marks sem end Evaluation as per the following rubrics [25 marks P1+25 marks P2}

Major Core Course	CIE	Experimental Report	Viva	Total
MJ I	15 M	5 M	5 M	25 M
MJ II	15 M	5 M	5 M	25 M

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'P' designates postgraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (SI – Ist Semester)
4. Letter 'ZO' is for Zoology discipline (ZO-Zoology). This forms the programme code 23PSZO. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Discipline Specific elective course code, (DSE) alphabets followed by a digit (1/2) followed by three letters specifying the course title are used.
8. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.

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