S.P Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for Sem III and Sem IV

Program: M.Sc. Zoology

Course-Biotechnology & Animal Physiology

(Credit Based Semester and Grading System with effect from the academic year 2019-2020)

RAMNARAIN RUIA AUTONOMOUS COLLEGE

M.Sc. in Zoology: SEMESTER III and IV

Credit Based Semester and Grading System to be implemented from the Academic Year 2013-2014

PREAMBLE

BOS in Zoology during its meeting constituted a pyramid committee, to revise the syllabi in Zoology, with Dr. M. K. Pejaver as the Chairperson and Senior Teachers from affiliated Colleges as Jt. Chairperson, one each for UG and PG programmes. The class-wise syllabus committees were constituted in accordance with inclusive policy of the BOS with an aim to provide faculty at large hands on training and exposure to work on syllabus committees which will go a long way in taking our subject ahead in future when these experienced staff members would shape the subject after a decade. With the introduction of Credit Based Semester and Grading System and continuous evaluation consisting of components of internal assessment and external assessment by the esteemed University, the syllabus in Zoology was revised for M.Sc. Sem I and II to be implemented with effect from 2012-13, after approval by concerned authorities of the University.

Vide University Circular No. APD/Misc.-01/407/of 2011 dated 12/12/2011, contents of letter from K. 1. Singh, Joint Secretary, UGC No. D.O.F1-1/2009-(CPP-II) dated 29/11/2011 were notified to the faculty in Zoology. As per the letter an expert committee was constituted by the UGC to look into the issue of discontinuation of dissection of live animals in the laboratory experiments in Zoology/ Life Sciences at UG and PG levels. The guidelines prepared by the expert committee and approved by UGC were notified with a viewpoint to ensure compliance of the guidelines.

A special meeting of Heads of Zoology Departments of all the Colleges affiliated to the University was convened on 17th August 2012 for deliberation on recommendation of expert committee appointed by the UGC regarding the discontinuation of dissection of live animals in laboratory experiments in Zoology / Life Sciences at UG and PG level.

In accordance with the deliberations in the above meeting, draft syllabus for M.Sc. SEMESTER-III and IV in Zoology, suitably revised, to be implemented in the Credit Based Semester and Grading System was prepared by the committee under the guidance of pyramid committee. The draft was circulated among the heads and senior teachers of the Department of Zoology of various colleges for approval and suggestions.

In meeting of the BOS geld on 12th December, the draft was approved and it was resolved to implement the revised syllabus of Zoology at M.Sc. SEMESTER-III and IV and make it effective from the Academic Year 2013-2014 after approval from concerned authorities of the University.

Chairman

Board of Studies in Zoology
University of Mumbai

M.Sc. Semester III and IV

Zoology- Biotechnology

Credit Based Semester and Grading System.

To Be Implemented from the Academic Year 2019-2020.

Semester –III

Course	Unit	TOPIC	Credits	L / Week
		The implications of recombinant DNA		
	I	technology of commercial products and		1
		microbial synthesis		
		Large scale culture & production from		
RPSZOO301			4	
	II	recombinant microorganisms & genetically		1
		engineered animal cells		
	III	Medical Biotechnology		1
	IV	Environmental Biotechnology I		1
	I	Genome management and analysis		1
		Manipulation of gene expression in		
RPSZOO302	II	prokaryotes	4	1
	III	Bioinformatics		1
	IV	Animal biotechnology and Human therapies		1
			08	**08**
		Practicals		
		Practicals based on RPSZOO301	2	4
		Practicals based on RPSZOO302	2	4
Total			**04**	**08**
TOTAL			**12**	**16**

M.Sc ZOOLOGY
(THEORY)

SEMESTER - III

Paper I

Paper Code: RPSZOO301

BASICS OF INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY I

Learning objective: Students will develop broad understanding of recombinant DNA technology and its benefits, the strains used at industrial level for fermentation, methods for production of monoclonal antibodies and vaccines.

Learning outcome: Students will get opportunities in areas like biotech companies, research and development institutes and in pharmaceutical industries.

Unit I: The implications of recombinant DNA technology of commercial products and microbial synthesis. 15L

1.1. The implications of recombinant DNA technology

1.1.1 General account on applications of biotechnology

1.1.2 Commercialization of biotechnology & biotech companies

1.1.3 Prospects of novel food technology

1.1.4 Economics of microbial biotechnology

1.1.5 Areas of significant public concern: Antibiotic resistance marker gene, transfer of allergies, pollen transfer from GM plants, social, moral & ethical issues associated with GMOs.

1.2 Amino acids & their commercial use – production strain, process of L- glutamate, L-aspartate, L-phenylalanine, L-tryptophan.

Unit II: Large scale culture & production from recombinant microorganisms & genetically engineered animal cells 15L

2.1. Large scale culture & production from recombinant microorganisms:

2.1.1 Batch fermentation

2.1.2 Fed batch fermentation

2.1.3Continuous fermentation

2.1.4 Maximizing the efficiency of fermentation process

2.1.5 Harvesting, disrupting & downstream processing

2.2. Large scale culture & production from genetically engineered animal cell cultures:

2.2.1 Design of bioreactors for large scale animal cell culture-Batch, Fed batch

2.2.2 Mammalian cell lines & their characteristics

2.2.3 Media for the cultivation of mammalian cells

2.2.4 Commercial products produced with mammalian cell culture

Unit III: Medical Biotechnology
15L

3.1. Sub-unit vaccines

3.1.1 Sub-unit Vaccine production against viruses-Herpes simplex, Bovine foot & mouth disease virus

3.1.2 Peptide vaccines-synthetic drugs (engineered proteins)

3.1.3 Genetic immunization-DNA vaccines, Antisense DNA, Therapeutic ribozymes

3.1.4 Live recombinant vaccines

3.1.5 Attenuated vaccines against Cholera, Salmonella sp.

3.1.6 Vector vaccines-Vaccine directed against viruses-Rabies virus G-protein, Hepatitis B surface antigen

3.1.7 Anti-idiotypic vaccine for cancer treatment.

3.1.8 Multivalent subunit vaccine.

3.1.9 Microbiome**.**

3.2. Monoclonal antibodies (mAbs) &therapeutic applications:

3.2.1 mAbs for prevention of rejection of transplanted organs

3.2.2 Treatment of bacterial blood infection

3.2.3 Human and Hybridmonoclonal antibodies

3.2.4 HIV therapeutic agents and Anti tumor antibodies

Unit IV: Environmental Biotechnology I
15L

4.1. Biomass utilization

4.1.1 Microorganisms in lignocellulose degradation

4.1.2 Isolation of prokaryotic & eukaryotic cellulase gene

4.1.3 Manipulation of cellulase gene

4.1.4 Production of single cell proteins by using biomass as raw material

4.1.5 Commercial production of fructose and alcohol from biomass

4.1.6 Improvements of fructose and alcohol production

4.1.7 Fuel ethanol from biomass.

4.1.8 Biogas utilization

4.2. Bioremediation of aerobic compounds

4.2.1 Characteristics of xenobiotics in the environment

4.2.2 Characteristics of aerobic microorganisms for degradation of organic pollutants

4.2.3 Genetic engineering of biodegradative pathways-Manipulation by transfer of plasmid, manipulation by gene alteration

4.2.4 Degradation of xenobiotic compounds-petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organic compounds (aliphatic & aromatic)

Paper Code: RPSZOO302

GENETIC ENGINEERING TECHNIQUES AND ITS APPLICATONS

Learning objectives: The aim of the course is to teach students genomics, proteomics and acquaint the students to versatile tools and techniques employed in genetic engineering. Bioinformatics will explore the students about interpretation of biological data.

Learning outcomes: Upon successful completion the students can apply the obtained knowledge in basic and applied field of biological research. They will have opportunities in Bioinformatics Company. And also the content of syllabus will help them to face competitive exams.

Unit I: Genome management and analysis **15L**

1.1 The Basic tools of genetic engineering

1.1.1 Chemical Synthesis of DNA-Oligonucleotide synthesis by Phosphoramidite method, Synthesis of genes

1.1.2 DNA Sequencing -- Maxam-Gilbert method, Sanger's dideoxynucleotide method, By using bacteriophage M13 By Primer walking, Next generation sequencing

1.1.3. PCR and its types (RT- PCR, nested and multiplex)

1.2 Cloning Vectors

1.2.1General purpose plasmid vectors (pUC19, pBR322) (BacterialVectors)

1.2.2Bacteriophage and cosmid vectors

1.2.3Yeast artificial chromosomes (YACs)

1.3 Analysis of genome/proteome

1.3.1DNA fingerprinting/physical mapping/pulsed field gel electrophoresis

1.3.2Analysis of the proteome– 2D PAGE & Mass spectroscopy.

1.3.3Analysis of mRNA transcripts– DNA Microarray.

Unit II: Manipulation of gene expression in prokaryotes **15L**

2.1 Promoters of gene expression in prokaryotes

2.1.1 Prokaryotic gene expression
2.1.2 Isolation of functional promoters
2.1.3 Promoter selection with E.coli plasmid pBR316
2.1.4 Promoter selection with plasmid pKO1
2.1.5 Gene expression from strong and regulatable promoters

2.2 Expression of cloned genes in prokaryotes

2.2.1 Increasing protein production and secretion
2.2.2 Inclusion bodies and fusion proteins
2.2.3 Unidirectional tandem gene arrays
2.2.4 Translation expression vectors
2.2.5 Increasing protein stability

Unit III: Bioinformatics **15L**

3.1 Uses and application of computers in biological sciences
3.2 DNA profiling: cDNA and EST's (expressed sequence tags)
3.3 Basic research with DNA microarrays and its application in healthcare.
3.4 Biomedical genome research and pharmaco genomics
3.5 Random amplified polymorphic DNA (RAPD)
3.6 Human genomic variation-SNP's (single nucleotide polymorphisms,SNP's and

disease; QTL (quantitative trait loci) and its relation to SNP's

3.7 Satellite DNA and its types

Unit IV: Animal biotechnology and Human therapies **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 biopharmaceuticals Transgenic insects and birds,
4.1.2 Recombinant DNA technology to prevent animal diseases
4.1.3 Conservation biology-Embryo transfer
4.1.4 Regulation of transgenic animals and patenting genetically engineered

animals Knock out mice (Cre- loxP sysem)

4.2 Human therapies
4.2.1Tissue engineering: Skin, liver, pancreas
4.2.2*****Xenotransplantation
4.2.3 Antibody engineering
4.2.4 Cell adhesion based therapies: Integrins, Inflammation, Cancer and metastasis
4.2.5 Targeted gene replacement for correcting a mutated gene
4.2.6 Site directed mutagenesis

SEMESTER III- PRACTICALS

Course Code - RPSZOO301 & RPSZOO302

1) Demonstration of aseptic technique: Work place for aseptic handling, packing glassware (flasks, test tubes, pipettes, petridish) for sterilization, aseptic transfer of liquids (pipetting from flask to test tube)
2) Preparation of LB agar plate, slant, butt & demonstration of streaking technique using bacterial culture to obtain isolated colonies.
3) Isolation of bacterial culture on differential media (Mac Conkeys agar).
4) Determination of Air microflora
5) Determination of viable cell count in the given culture of bacteria by dilution,spreading and pour plate technique.
6) Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis.
7) To estimate the number of bacteria in the given culture by nephelometry..

SEMESTER–IV

Theory				
Course	Unit	TOPIC	Credits	L / Week
RPSZOO401	I	Microbial synthesis of commercial products	4	1
	II	Large scale culture & production for industrial biotechnology		1
	III	Agricultural Biotechnology		1
	IV	Environmental Biotechnology II		1
RPSZOO402	I	Genome management	4	1
	II	Manipulation of gene expression in eukaryotes		1
	III	The human genome project		1
	IV	Regulations and patents in biotechnology		1
			08	**08**
		Practicals		
		Practicals based on RPSZOO401	2	4
		Practicals based on RPSZOO402	2	4
Total			**04**	**08**
TOTAL			**12**	**16**

SEMETER – IV

Paper I

Paper Code: RPZOO401

BASICS OF INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY II

Learning objectives: The course is designed to develop the student's ability to understand about techniques used on industrial level, analytical aspects of enzymes. Students will learn about the micro-organisms used at commercial level and how biotechnology help in improving agricultural yields and also it will give an idea of environmental application of micro-organism.

Learning Outcomes: Students will have opportunities in research and development related to environmental and agricultural work. They can work in area's dealing with waste management.

Unit I: Microbial synthesis of commercial products **15L**

1.1. Microbial synthesis of commercial products.

1.1.1 Organic acids & their commercial applications – Citric acid, gluconic acid, lactic acid, Acetic acid.

1.1.2 Antibiotics – Cloning antibiotic biosynthetic gene by complementation & other Aminoglycosides & their uses

1.1.3 Polysaccharides:

Bacterial polysaccharides: General properties & their commercial applications- Dextran, Xanthan, Alginate.

Genetic engineering for the large scale production of Xanthan gum & it's modification Marine polysaccharides: General properties & their commercial application-Agar &agarose, Chitosan

1.1.4 Polyesters: Polyhydroxyalkanoates (PHA)-Biosynthesis of PHA, Biopol-commercial biodegradable plastic

Unit II: Large scale culture & production for industrial biotechnology **15L**

2.1. Biotransformations :

2.1.1 Selection of biocatalyst-screening & use of novel existing biocatalyst

2.1.2 Genetic modification of existing biocatalyst (Indigo biosynthesis)

2.1.3 Biocatalyst immobilization-

Methods of immobilization- Cross linking, supported immobilization, adsorption & ionic binding, covalent coupling, lattice entrapment

2.1.4 Immobilized soluble enzymes & suspended cells

2.1.5 Immobilization of multi-enzyme systems & cells

2.1.6 Immobilized enzyme reactors- Batch reactors, continuous reactors

Analytical enzymes- Enzymes in diagnostic assays: Test strip systems & Biosensor
2.1.7 Electrochemical & optical type.

Unit III: Agricultural Biotechnology **15L**

3.1. Agricultural Biotechnology:

3.1.1 Nitrogen fixation

3.1.2 Nitogenase-Component of nitrogenase; Genetic engineering of nitrogenase cluster

3.1.3 Hydrogenase-Hydrogen metabolism

3.1.4 Genetic engineering of hydrogenase gene

3.1.5 Nodulation-Competition among nodulation organisms, genetic engineering of nodulation gene

3.1.6 Microbial insecticides-Toxins of *Bacillus thuringiensis*, mode of action & use of thuringiensis toxins, thuringiensis toxin gene isolation, genetic engineering of *Bacillus thuringiensis*strains& cloning of thuringiotoxin gene.

3.1.7Developing insect resistant, virus resistant & herbicide resistant plant

3.1.8 Algal products: Fuels from algae, marine natural products & their medical potential-anticancer, antiviral compounds, antibacterial agents.

Unit IV: Environmental Biotechnology II **15L**

4.1. Bioabsorption of metals (Recovery from effluents)

4.1.1 *****Bioabsorption by fungi, algae, moss & bacteria

4.1.2 Mechanism of bacterial metal resistance & genetic engineering for specific Proteins.

4.1.3 Bioreactors for bioabsorption-packed bed, fluidized bed, rotating disc, single blanket, sequential reactors

4.1.4 Phytoremediation &its use in biotechnology

4.2. Bioleaching of metals

4.2.1 Biochemical mechanism of bioleaching

4.2.2 Extraction from mixtures

4.2.3 Types of bioleaching

4.2.4 Methods for bioleaching-Tank & heap bioleaching

4.2.5*****Microorganisms used for bioleching

SEMESTER – IV
Paper II
Paper Code: RPZOO402

GENOME MANAGEMENT, MANIPULATION, REGULATIONS AND PATENTS IN BIOTECHNOLOGY

Learning Objectives: The objective of the syllabus is to give the students' knowledge about how genetic techniques can be used to manipulate genome, various assays used for identification of gene product. It will give students idea about patenting biotechnology.
Learning outcomes: The subject will help the students to work in research related to genetic engineering,. The techniques taught will help the student to work in immunology department of pathology lab

Unit I: Genome management **15L**

1.1 The 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. Flow cytometry.

1.2 Cloning Vectors

1.2.1Retrovirus and SV40 vectors

1.2.2Special purpose vectors- Expression vectors, Secretion vectors,Shuttle or bi-functional vectors, single stranded phage and phagemids.

Unit II: Manipulation of gene expression in eukaryotes **15L**

2.1 Eukaryotic gene expression
2.2 Introduction of DNA into fungi-yeast and filamentous fungi (fungal transformation)
2.3 Heterologous proteins production in yeasts
2.4 Heterologous proteins production in filamentous fungi
2.5Cultured insect cells expression systems-Baculovirus transfer vector
2.6 Mammalian cell expression systems-Human Papova BK virus shuttle vector

Unit III: The human genome project **15L**

3.1 The human genome, scope and goals of the project
3.2 Genetic linkage maps, chromosome walking, restriction mapping
3.3 Polymorphic DNA markers(RFLP, AFLP, VNTR)
3.4 Restriction fragment length polymorphism (RFLP) and its uses
RNAi and is application to treat human disease.
3.5 Physical maps, Sequence tagged sites
3.6 Integrating genetic linkage and physical maps
3.7 Mapping human diseases
3.8Positional cloning: Getting closer to a disease causing gene (Cystic fibrosis)
3.9 Testing for exons

3.10 Limitations of positional cloning. FISH

Unit IV: Regulations and patents in biotechnology 15L

4.1 Regulating recombinant DNA technology

4.2 Regulatory requirements – safety of genetically engineered foods Chymosin,

tryptophan, bovine somatotropin

4.3 Regulation environmental release of genetically engineered organism(GEO). Ice minus Pseudomonas syringae

4.4 Regulatory agencies and laws for product regulation

4.5 Risk assessment: How much risk?

4.6 Open field tests of GEO

4.7 Development of policy for Human gene therapy

4.8 Patenting biotechnology inventions

a. What constitutes the patent?
b. The patent process
c. The conditions to be satisfied for an invention to be patentable :Novelty, Inventiveness, Usefulness
d. Patenting in different countries, types of inventions that are not patentable in India
e. What is Paris convention? Principal features of Paris convention
f. Patenting multicellular organisms
g. Patenting & Fundamental Research

PRACTICAL

SEMESTER IV

Course Code PSZOBT401 & PSZOBT402

1) Immobilize Yeast cells in calcium alginate & prepare a bioreactor column to demonstrate Invertase activity in the bioreactor column.
2) Restriction-digest the given DNA sample &demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided.
3) Demonstrate the western blotting technique for the given sample of protein.
4) To plot a growth curve for the microorganisms provided.
5) Demonstrate the effect of medium on growth curves of given microorganism, using two different media (minimal &enriched).
6) To determine the potability of given water sample by MPN method.
7) Antibiotic sensitivity test.

REFERENCES:

Semester III & IV
Biotechnology

1. Johan E. Smith, Biotechnology, 3rd Edition, Cambridge Univ. Press
2. Colin Rateledge and Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge Univ. Press
3. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.
4. InduShekar Thakur, Environmental Biotechnology – Basic concepts and applications, I. K. International Pvt. Ltd, Mumbai, New Delhi
5. John A. Thomas (Ed.), Biotechnology and safety assessments, 2nd Edition, Taylor and Francis
6. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers
7. Martin Fransman, GerdJunne, AnnemiekeRoobeek (Ed), The Biotechnology revolution?, Blackwell Scientific Publishers
8. Terence Cartwright, Animal Cells as Bioreactors, Cambridge Univ. Press
9. Rosevear, John F. Kennedy, Joaquim M. S. Cabral, Immobilized enzymes and cells, Adam Hilger Publishers, Bristol and Philadelphia
10. Micheal P. Tombs and Stepan E. Harding, An Introduction to polysaccharide biotechnology
11. T. A. Brown, Gene Cloning – An Introduction, 3rd Edition, Nelson Thornes
12. Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Publishers
13. U. Satyanarayan, Biotechnology, 2007 Reprint, Uppala Author Publisher Interlink
14. Susan R. Burman Biotechnology- An Introduction Vikas Publishing House.
15. Patent Facility Centre (PTC) Technology information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, New Delhi
16. S. S. Purohit, Biotechnology – Fundamentals and applications, 3rd Edition, Agrobios, India

MODALITY OF ASSESSMENT :

A) Internal Assessment- 40%

a) Theory

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	20
2.	One class Test (multiple choice objective question)	15
3.	Active participation in routine class instructional deliveries (case studies/seminars/presentations)	05
4.	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular,	05

b) Practicals

Sr. No.	Evaluation type	Marks
1.	Based on the theory paper	40
2.	Journal	05
3.	Viva	05

B) External examination- 60%

a) Semester End Theory Assessment- 60%
60 Marks

i)Duration - These examinations shall be of two hours 30 mins duration for each paper.

ii) Theory Question Paper Pattern:-

- There shall be five questions each of 12 marks. On each unit there will be one question and the last question will be based on entire syllabus.
- All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 20 marks with options.
- Question may be subdivided into sub-questions a, b, c… and the allocation of marks depend on the weightage of the topic.

b) Practicals 50 Marks

M.Sc. ZOOLOGY

SemesterIII /Semester IV EXAMINATION

2019-2020

Course code:_____

Maximum Marks: 60
Duration: 2 Hours 30 Mins
Marks Option: 90

Question 1: Unit I
Question 2: Unit II
Question 3: Unit III
Question 4: Unit IV
Question 5: Unit I to Unit IV (Mixed Questions)

Instructions:
i.All questions are compulsory.
ii.All questions carry equal marks.
iii.Draw neat and labeled diagrams wherever necessary.

1. Answer any two questions from the following (Based on Unit I)- 6 MARKS EACH
a.
b.
c.

2.Answer any two questions from the following (Based on Unit II)-6 MARKS EACH
a.
b.
c.

3.Answer any two questions from the following (Based on Unit III)- 6 MARKS EACH
a.
b.
c.

4.Answer any two questions from the following (Based on Unit IV)- 6 MARKS EACH
a.
b.
c.

5.Answer any four questions from the following (Based on entire syllabus) -3 MARKS EACH
a.
b.
c.
d.
e.
f.

Details of project component for semester III & IV are as follows:

1) A student will submit an outline/scheme of the project proposal.
2) Practical work for the project will be carried out in semester IV.
3) Each student will choose a different topic related to the syllabus.
4) The teacher who has done specialization in that subject will guide the students.
5) Each student will submit a project proposal i.e. a hard copy during practical exam of semester III
6) Each student will submit a dissertation of the project done during practical exam of semester IV
7) The student will also give a power point presentation about the project done (Not more than 10 slides) during semester IV.
8) The project proposal, dissertation, a power point presentation along with other points mentioned in the tables below will be evaluated **equally** by an internal (who guided them during the project work) as well as an external examiner.

Semester III

Literature survey	08
Topic / Title	02
Objective and purpose	08
Material and Method	08
Work plan with timeline	08
Expected outcome	08
Viva voce based on proposal	08
Total- 50 Marks	

Semester IV

Abstract	04
Material methods	04
Procedure followed	04
Observation	04
Interpretation of results	06
Conclusion and discussion	08
Bibliography	04
Viva voce base on the project	08
Power point presentation	08
Total- 50 Marks	

M.Sc. Semester III and IV

Zoology-Animal Physiology

Semester –III

Theory				
Course	Unit	TOPIC	Credits	L / Week
RPSZOO301	I	The implications of recombinant DNA technology of commercial products and microbial synthesis	4	1
	II	Large scale culture & production from recombinant microorganisms & genetically engineered animal cells		1
	III	Medical Biotechnology		1
	IV	Environmental Biotechnology I		1
RPSZOO302	I	Genome management and analysis	4	1
	II	Manipulation of gene expression in prokaryotes		1
	III	Bioinformatics		1
	IV	Animal biotechnology and Human therapies		1
RPSZOP303	I	Level of response and Nutritional Physiology	4	1
	II	Dynamics of physiological fluids		1
	III	Physiological of mobility & Continuity of Life		1
	IV	Neuroendocrine regulation, sensory & effecter physiology		1
RPSZOP304	I	Stress, Water and pressure as environmental factors	4	1
	II	Oxygen and Temperature as environmental factors		1
	III	Environmental Radiation, physiology of Biological Timing		1
	IV	Physiological Tools for clinical diagnostics		1
			16	**16**
Practicals				
		Practical Paper-1	2	4
		Practicals Paper-2	2	4
		Practical Paper- 3	2	4
		Practicals Paper-4	**2**	**4**
Total			**8**	**16**
Grand Total			**24**	**32**

Course code- RPSZOP303
Comprehensive Physiology-I.

UNIT I: Levels of response and Nutritional Physiology. 15 L

Levels of Physiological response- Molecular, Membrane, Organ and Organism.
A brief idea of physiological response at molecular level
Membrane physiology- Functional consequences of molecular composition and arrangement.
Transport across cell membrane-* Diffusion ***** active transport, pump; uniports, symports and antiport, co-transport by symporters and anitporters.
Physiology of Food Capture and Processing:
Nutritive Patterns: Origin of nutritive types.
Feeding patterns:

a) Large particle feeding
b) Surface nutrient absorption

Digestion:

a) Bulk movement and peristalsis
b) Comparative biochemistry of digestion
c) Neural and hormonal regulation of secretion of digestive enzymes.

Regulation of nutritional intake:

a) Hunger drive, Glucostatic and Hepatostatic theories of hunger drive
b) Adaptation of gut to metabolic rate and diet.
c) *Balanced diet: A human perspective

UNIT II: Dynamics of physiological fluids-circulation. 15 L

Circulation of body fluids:
a) Circulating fluids-Cytoplasm, Hydrolymph, hemolymph, lymph and Blood
b) Circulatory mechanisms and Fluid compartments, movement of body fluids by somatic muscles. Hemolymph and open systems
Pressure and flow in vertebrate circulatory system
Physiological types of hearts with special reference to arthropods, annelids, mollusca, tunicates and vertebrates.
Pacemakers and specialized conducting fibers.
Selective distribution of blood flow.
Cardiac Physiology:
Neurohormonal regulation of cardiac amplitude and frequency.
*Effects of exercise on cardiac vascular physiology - A human perspective.

UNIT III: Physiology of motility. 15 L

Physiology of movement and locomotion:
*Biochemistry of contractile proteins.
Physiology of non-muscular contractile elements: Axoplasmic movement, Chromosome involvement
Physiology of skeletal muscle fibre:

a) Actomyosin complex
b) Source of energy for muscle contraction
c) *Sliding filament theory
d) Excitation of contraction and mechanism of regulation of contraction by calcium
e) Mechanism of relaxation

Comparative physiology of invertebrate muscle:

a) Polyneural innervation in anthropod muscle
b) Insect non-oscillatory postural muscle
c) Resonant flight and tymbal muscle in insects
d) Catch muscle and delayed relaxation

UNIT IV: Neurotransmission Physiology. **15 L**

Physiology of neuronal system:
Excitable membranes:

a) Membranes potential
b) Ions as current carriers - Protons, calcium, potassium, structure of cation-permeable channels and chloride channels

Synaptic transmission:

c) Electrical transmission
d) Chemical transmitters- Neuropeptide, FMRF-amide family, Gastrin, CCK family, Hypothalamic pituitary factors

Integrative Neurophysiology: Neurons, Interneurons, neural Circuits, Networks, Primitive Nervous Systems, Nerve nets, Central pattern Generators in Invertebrates, Chordate Nervous System, Central Nervous System processing

* Memory and Learning.
* Indicate topics for learners to present seminars on

Course Code: RPSZOP304
Environmental and Applied physiology-I.

Unit I: Stress, Water as an environmental factor. **15 L**

Environmental Stress, Homeostasis and strategies of biochemical adaptations:
Basic concept of environmental stress

a) Plastic and elastic strain
b) Stress resistance, stress avoidance and stress tolerance* – Seminar topics

Homeostasis and biochemical adaptation:

c) External and internal environment
d) Multiple control system
e) Strategies of biochemical adaptations

Water and Solute problem:
Preservation of intracellular solvent capacity
Strategies and degrees of ionic regulation
ATPase the model regulatory enzyme
Key role of GDH reaction
*Salt glands in animal kingdom.

Unit II: Oxygen as environmental factor. **15 L**

Oxygen as an environmental factor:
*Oxygen and Origin of life
Oxygen dependencies in living organism
Anoxia adaptations in invertebrates
Adaptations of vertebrates during prolonged diving
Oxygen debt in vertebrate muscle

Unit III: Environmental Radiation. **15 L**

Radiation as an environmental parameter:
The solar spectrum
Biomolecules involved in perception and trapping of solar radiations: Chlorophyll, Bacterio-rhodospin, Rhodospin and Vitamin A. Adaptations of animals to absence of solar radiations
Effects of Ionizing radiations at the cellular and molecular level
Phenomenon of radioprotection
Effects of Ionization radiations at cellular and molecular level
Phenomenon of radioprotection.

Unit IV: Enzymes and Body Fluids as Clinical Diagnostic Tools. **15 L**

Enzymes as diagnostic tools :
Plasma specific and non-plasma specific enzymes
Diagnostic importance of LDH
Enzyme in diagnosis of myocardial infarction
Enzymes in Liver diseases and toxicity
Enzymes in muscle disease
*Enzymes in cancer
Body fluid parameters as diagnostic tools:

Physiological fluids as diagnostic tools:
Routine Blood tests, plasma composition- changes in disease
Serum: Urea-N, Creatinine, Uric acid, proteins, bicarbonates, Na^+ K^+ Cl^-
Glucose tolerance test, glycosylated Haemoglobin
Lymph and cerebro-spinal-fluid: Changes in composition in disease –
* Urine composition/ constituents as a diagnostic tool-Routine Urine tests, Urea-N, Creatinine, Uric acid, tests for proteinurea, albuminurea, Glucosurea, chyluria (for filariasis)
* **Indicate topics for learners to present seminars on.**

Course Code: **RPSZOP303 & RPSZOP304**

1) Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin, Lipase etc. in different animals (Cockroach)
2) Study of effect on activity of any enzyme of various factors like pH, Temperature, Activator, Inhibitor
3) Determination of Km of a given enzyme
4) Total RBC, WBC and Different WBC count- A comparative study of fish, goat and human
5) Routine human blood tests like RBC, WBC, DWBC, Hb content, blood sugar. prepare a report as required by a pathological laboratory (goat blood)
6) Observation of decreasing PO_2 of water on the respiratory rate of a fish
7) Effect of decreasing PO2 of water on Lactic acid in the muscle.
8) Estimation of salt loss and gain in an aquatic animal when it is transferred to a salt- free medium and to natural medium.
9) Preparation of glycerinated muscle fibre and study of its properties.
10) Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.

Semester –IV

Theory				
Course	Unit	TOPIC	Credits	L / Week
RPSZOO401	I	Microbial synthesis of commercial products	4	1
	II	Large scale culture & production for industrial biotechnology		1
	III	Agricultural Biotechnology		1
	IV	Environmental Biotechnology II		1
RPSZOO402	I	Genome management	4	1
	II	Manipulation of gene expression in eukaryotes		1
	III	The human genome project		1
	IV	Regulations and patents in biotechnology		1
RPSZOP403	I	Level of response and Nutritional Physiology	4	1
	II	Dynamics of physiological fluids		1
	III	Physiological of mobility & Continuity of Life		1
	IV	Neuroendocrine regulation, sensory & effecter physiology		1
RPSZOP404	I	Stress, Water and pressure as environmental factors	4	1
	II	Oxygen and Temperature as environmental factors		1
	III	Environmental Radiation, physiology of Biological Timing		1
	IV	Physiological Tools for clinical diagnostics		1
			16	**16**
Practicals				
		Practicals based On paper 1	2	4
		Practicals based on paper 2	2	4
		Practicals based on paper 3	2	4
		Practicals based on paper 4	**2**	**4**
Total			**8**	**16**
Grand Total			**24**	**32**

Course Code: **RPSZOP403**

Comprehensive Physiology-II

UNIT I: Physiology of Respiration and Nitrogen Metabolism . 15 L

Respiration:

*Transition from water to land- Vertebrates and invertebrates

O2 consumption, RQ and modifying agents:

Activity, Temperature, Salinity, Photoperiod, Development, Hibernation, Animal size and metabolism.

Respiratory functions of blood:

*Respiratory pigments,respiratory acidosis and alkalosis, Alkali reserve Control and co-ordination of respiration

Nitrogen Metabolism:

Amino-N Metabolism, Nucleic acid metabolism, Nitrogenous waste products.

Ammonia toxicity and detoxification pathways-

* Ammonotely, Ureotely, Purinotely, uricotely, Storage excretion.

Patterns of detoxification pathways in eggs and during metamorphosis,

Phylogenetic patterns.

UNIT II: Dynamics of physiological fluids-composition. 15 L

Dynamics of fluid composition:

Body fluid composition- water, solute and Intracellular regulation.

Cutaneous evaporation, Respiratory evaporation,

Integrated functioning for nitrogen excretion and osmoregulation Contractile vacuole, Coelomoducts, Flame cells, Green gland, Malpighian Tubules,

Invertebrate Nephredia and Vertebrate Nephron

Comparative physiology of vertebrate kidney

*Kidney stones and kidney transplants - a human perspective.

Transfusion, Blood Replacement- A human perspective.

Haemodialysis and peritoneal dialysis- A human perspective.

UNIT III: Physiology of Continuity of Life. **15 L**

Physiology of Reproduction:

Selfish gene, evolution of gametes, maternal DNA

Endocrine regulation of reproduction in invertebrates, Molluscs,

Crustaceans, Insects

Comparative account of vertebrate gonadotropins, gonadal steroids,

* Interaction of steroid hormones and nervous tissue.

Human intervention in Reproduction Contraceptives,

MTP, Treatment of Infertility.Assisted Reproduction

Techniques- IFV, GIFT, ICSI, ZIFT, DI, AID

UNIT – IV : Endocrine regulation, sensory & effecter physiology. **15 L**

Physiology of Endocrine Regulation:
Specificity, Membrane bound receptor system, Cytosolic receptor system
*Invertebrate Endocrine System
Lower invertebrates, Annelids, Molluscs, Crustaceans, Insects
Regulated supply of hormones: Feedback: Direct and Indirect Hypothalamo-Hypophysical axis, Pineal- Pituitary gland, Thyroid and Adrenal gland, G-E-P (Gastro-entero-pancreatic) cells, Renal hormones Cardiac hormones, Prostaglandins.
Sensory and Effecter physiology
Sensory Physiology- Structural and Functional Classification, Modality Intensity, Sensory coding
Various receptors- Chemoreception, Mechanoreception , Electroreception Thermoreception, *Photoreception.
* Physiological effectors: Cnidoblasts, Bioluminescent systems Chromatophores, electric organs
* **Indicate topics for learners to present seminars on.**

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Course Code: **RPSZOP404** : Environmental and Applied physiology-II.

Unit I: Pressure as an environmental factor. **15 L**

1.1 Pressure as an environmental factor :
1.1 Fundamental effects of pressure on biological system
Rate of enzyme action with respect to pressure
Effect of pressure on weak bonds and the consequences for higher orders of Protein structure.
Effects of pressure on cellular processes viz. transcription, translation and gene regulation Strategies of enzyme adaptations to pressure in marine organisms: FDPase and PK

UNIT II: Temperature as environmental factor. **15 L**

Temperature Regulation/ Response to temperature fluctuations:
Thermal limits of survival
Temperature and Structural effects with response to Biological molecules and biological membranes
Temperature and rate effects: Temperature dependent E~S affinity, Lipoprotein enzymes
Thermal resistance of dormant and active cells
Ectothermy and endothermy
Endothermy in invertebrates
Biochemical adaptations of Ectothermy: Antifreeze substances, Heat shock proteins

UNIT III : Radiation and Physiology of Biological Rhythms . **15 L**

Physiology of Biological Rhythms and timings:
Temporal organization of the cells
Circadian Rhythms. Synchronization of circadian rhythms
Dormancy in fresh water and terrestrial animals
Preparatory phases, Induction of dormancy, Arousal from dormancy Entrainment and dormancy
Diapause in insects- Induction, Factors affecting and termination of Diapause,
Diapause and endocrine functions
*Photoperiodism
*Biological clocks

UNIT IV: Physiological Tools for clinical diagnostics. 1**5 L**

Antibodies as diagnostic tools:
RIA- of GnRH, Gonadotropins, T3, T4, TSH, HCG, Insulin
* ELISA- for detection of HCG, diagnosis of Amoebiasis, Typhoid, HIV
Monoclonal antibodies as diagnostic tools: Detection of HCG, Diagnostic of STD, Streptococcal throat infections, Herpes and Cancer
Organ Function Tests as diagnostic tools:
*Liver function tests and toxicity tests
Pancreatic function tests
Gastric function tests
Kidney function tests

* Indicate topics for learners to present seminars on.

Course Code: **RPSZOP403 & RPSZOP404**

1. Determination of Urea, Creatinine in blood -Human/goat
2. Determination of serum content of uric acid, cholesterol – Human/goat
3. Effect of injection of insulin/ glucagon on the blood sugar and liver glycogen in rat/ mouse
4. Routine urine tests and preparation of report as per pathological laboratory (treatment as in “Fundamentals of Practical clinical biochemistry pp 34-38, 40-43)
5. Performance of Ouchterlony technique to demonstrate immunodiffusion
6. Demonstration of single radical immunodiffusion of antibody and antigen
7. Influence of sub lethal (50-60ppm) ammonia (as liquor ammonia/ ammonium hydroxide/ ammonium chloride) on a suitable fish exposed to ammonia stress for
8. 3/7/15 days with reference to the following parameters:
    a. Level of excretory ammonia
    b. Level of activity of hepatic and brain glutamate dehydrogenase
    c. Level of amino acid content of muscle, gill, brain and liver
9. A survey based project to study physiological diagnostic tools with the help of local pathological laboratory/ hospital.
10. Effect of administration of carbon tetra chloride in rat/mice with reference to following parameters
    a) Total lipid and free fatty acid content of liver
    b) Free fatty acid content of plasma
    c) Level of activity of the following enzymes: AspAT, AlaAT, AICP, ACP, LDH, SDH and ATPase

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OCEANOGRAPHY

M.Sc. Semester III and IV
Zoology--Oceanography and Fishery Science

SEMETER – III

PSZOOCN303- GENERAL, PHYSICAL, CHEMICAL AND BIOLOGICAL OCEANOGRAPHY

Objectives and Outcomes:

- Explain the theory of plate tectonics and its relationship to the formation of the major features of the sea-floor
- Demonstrate how the oceans are connected to and drive major Earth ocean processes, such as atmospheric and oceanic circulation, climate and weather being helpful to students in the field of research.

UNIT I: GENERAL OCEANOGRAPHY 15 L

1.1Terminology of submarine topography

Continental shelf, continental slope, submarine canyons, submarine mountain ranges, Guyots and trenches with special reference to the Indian Ocean and adjacent seas.

* 1.2 **A general knowledge of typical oceanographic research vessel and its equipments, oceanographic labs and stations of the world and India.**

* General properties of sea water: Salinity, Chlorinity, Temperature, Light, Density, Pressure, Salinity-Temperature-Density Relationship (STD).

UNIT II: PHYSICAL OCEANOGRAPHY 15 L

2.1 Vertical circulation: wind induced circulation, Thermohaline circulation and upwelling of water.

2.2 Waves: Characteristics of waves, deep water and shallow water waves, transitional waves, wind generated waves, internal waves and Tsunami

***2.3 Tides:** Tides generating forces, equilibrium theory of tides, dynamic theory of tides, tides as a source of power.

*** 2.4 Currents:** Types of currents, major currents of the world, Coriolis effect and El Nino effect.

2.5 Oceanographic circulation:

Ekman spiral, geotropic current, westward intensification with dynamic topography.

UNIT III: CHEMICAL OCEANOGRAPHY 15 L

* **3.1 Composition of sea water-** constancy of its composition and factors affecting the composition, major and minor constituents, trace elements and their biological role.

* **3.2 Dissolved gases** in the sea water and their role in the environment, CO_2system, dissolved O_2 and oxygen profile, hydrogen sulphide.

3.3 Nutrients in the ocean, their cycles and factors influencing their distribution

a) Nitrogen b) Phosphorus c) Silicon.

UNIT IV: BIOLOGICAL OCEANOGRAPHY 15 L

***4.1 Division of marine environment.**

4.3 a)Marine biotic diversity: Plankton, Nekton, Benthos- brief account

Implications of species richness, measuring diversity, quadrients of species diversity, models explaining diversity gradient.

*b) Intertidal organisms and their zonation.

c) Changing shore lines and erosion.

4.4 Effect of physical factors on marine life

a) Light: photosynthesis, colouration, structural adaptations, bioluminescence.

b) Temperature: tolerance, geographical distribution, size, calcium precipitation, metabolism, bipolarity, tropical submergence and periodicity.

c) Salinity: tolerance and distribution, size, buoyancy and osmoregulation.

d) Currents: role in nutrition, transportation and propogation.

*e) Marine bacteria and their role.

***marked topics are to be taken for seminar**

SEMESTER III

PSZOOCN304- PLANKTOLOGY, FISH, FISHERY SCIENCE, IMMUNOLOGY OF FISH AND AQUACULTURE

Objectives and outcomes:

- An overview of fishery science and aquaculture industry will be explained
- Identify the role of the immunological system of fish, its components and various external factors that affect it.
- Since fish and seafood requirements on a global level are high, students will learn the major fisheries and different systems of aquaculture which could provide an alternate means of livelihood.

UNIT I: PLANKTOLOGY 15L

1.1. Classification of Plankton.

Adaptation to planktonic life.

Factors influencing the distribution and abundance, plankton bloom, patchiness, vertical distribution and red tide.

1.2. ***Diurnal migration of zooplankton.**

Inter-relationship between phyto and zooplankton.

UNIT II: FISH AND FISHERIES SCIENCE 15L

2.1. An overview of fish classification as per Francis Day and FAO.

2.2. a) Major commercial fisheries: Elasmobranchs (shark and ray)

Teleosts: Sciaenoids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Sole fish, Harpodon, Ribbon fish fisheries.

b) ***Crustacean fisheries:** Prawns (penaeid and non penaeid), Shrimps, Lobster and Crab.

c) ***Molluscan fisheries.**

d) Seaweeds

2.3 CRZ and fishing regulations

UNIT III : IMMUNOLOGY OF FISH 15L

3.1 Defense system : Specific and non-specific
3.2 Response to pathogens
3.3 Fish vaccinations
3.4 Ontogeny of fish immune system
3.5 Fish leucocytes

UNIT IV: AQUACULTURE 15L

4.1. ***History, scope and importance of aquaculture.**
Aquaculture practices in India.
Cultivable organisms for aquaculture and criterion for their selection.

4.2. **Different systems of aquaculture such as Pond Culture, Cage Culture, Pen Culture, Running Water Aquaculture, Raft Culture,Aquaranching.**

4.3 Aquaculture of Indian major carps and *MacrobrachiumRosenbergii*

4.4**Impact of aquaculture on environment.**

***marked topics are to be taken for seminar**

SEMESTER III- PRACTICALS

PSZOOCN3P3

1) Physical and chemical oceanography:
(Uniform methods foall colleges to be followed) Determination of physico-chemical parameters:
1)Salinity (Argentometric and conductivity method)
2)Dissolved oxygen,
3)Carbon dioxide.
4) Nitrates-nitrites.
5) Silicates.
6) Phosphate-phosphorus.

2) Textural features:
Sediment analysis- size fraction (sand, silt, clay)

3) Identification of foraminiferans and radiolarians from sand. 4) Estimation of primary productivity by light and dark bottle.

5) Identification of intertidal organisms:

a) Rocky shore- Patella, Chiton, Fissurella, Mytilus species, *Pernaviridis,* Cardium, Balanus, Gorgonids, Littorina and Corals.

b) Sandy shore:Solen, Umbonium, Oliva, Pea crab, Fiddler crab, Molluscan shells, Star

fish and Balanoglossus.

c) Muddy shore: Lingula, Chaetopterus, Arenicola, Tubiculus worm and Mud skipper.

d) Laboratory procedure for quantitative estimation of plankton settling method, wet weight method, weight displacement method, counting method.

1) Identification of Zooplankton permanent slides (Noctiluca, Obelia medusa, Zoea, Zoea porcelina, Copepods, Mysids, Echinoderm larvae, Nauplius, Sagitta, Doliolum, Salpa, Fish eggs and larvae, Jelly fish, Physalia, Porpita) **3)** Study of fecundity-maturation studies.

4) Plotting the frequency polygon by ova diameter measurement.

5) Identification and classification of Marine fishes

List of Marine fishes

Elasmobranchs

1. Family- Carcharidae

Carcharias sps. *Zygaena malleus*

2. Family- Rhinobatidae

Rhynchobatusdjeddensis

3. Family- Trygonidae

Trygonuarnak

Teleost

4. Family- Percidae

*Lutianusjohnii, Therapon*sps., ***Pristipomamaculatum, Synagris japonicus, Gerresfilamentosus***

5. Family- Squamipinnes

Scatophagusargus

6. Family – Mullidae

Upenoidesvittatus

7. Family- Polynemidae

Polynemustetradactylus

8. Family- Sciaenidae

*Pseudosciaenadiacanthus, Sciaena*sps.

9. Family- Trichuridae

Trichurussavala/ haumela

10. Family- Carangidae

Caranxrottleri, ***Chorinemustoloo***

11. Family- Stromatidae

Pampuschinensis, Pampus argenteus

12. Family- Scombridae

Rastrelligerkanagurta, Cybiumguttatum

13. Family- Trachinidae

Sillagosihama

14. Family- Cottidae

Platycephalus punctatus

15. Family- Gobidae

*Periophthalmus*sps., *Boleophthalmus*sps.

16. Family- Sphyraenidae

Sphyraenaacutippinis

17. Family- Mugillidae*Mugil*sps.

18. Family- Gadidae*Bregmaceros*sps.

19. Family- Pleuronectidae

Psettodeserumei, Cynoglossus elongatus

20. Family- Siluridae

Arius dussumieri

21. Family- Scopelidae

***Sauridatumbil**, Harpodonnehereus*

22. Family- Sombresocidae

*Belone stongylurus, Hemiramphus*sps.

23. Family- Clupeidae

Pellonafeligera, Clupea longiceps

24. Family- Chirocentridae

Chirocentrusdorab

25. Family- Muraenesox*Muraenesox*sps.

6) Cells and tissues of Immune system of fishes

SEMESTER -IV

Zoology-Biotechnology--Oceanography and Fishery Science

Credit Based Semester and Grading System.

PSZOOCN403: OCEANOGRAPHIC INSTRUMENTS AND EXPEDITIONS, MARINE ECOLOGY, MARINE POLLUTION AND BIOLOGICAL RESOURCES

UNIT I: OCEANOGRAPHIC INSTRUMENTS AND EXPEDITIONS15

Objectives and outcomes:

- Identify and explain the various oceanographic instruments for the purpose of studying physic-chemical parameters of the sea, necessary for research purposes.
- Study the various habitats of marine organisms and their variations.
- Analyze the repercussions of anthropogenic activities on the sea and resources obtained from the sea and economy they generate.

1.1 Oceanographic instruments:

Grab (Peterson and Van veen) for benthos collection, naturalist's dredge (Ekman Sanders deep sea anchor dredge), trawl, plankton nets and continuous plankton sampling system, Reversing Nansen bottles, Reversing thermometer, Salinometer, Secchi disc, Stempel's pipette and dilution jar, underwater photography, remote sensing and satellite imaging, SCUBA apparatus.

***1.2 Oceanographic Expeditions:** Challenger, Indian Ocean and Antarctic.

1.3 Law of sea.

UNIT II: MARINE ECOLOGY 15 L

2.1 Coastal ecosystems, estuaries, Coral reefs and Bays

2.2 Salt marshes and salt pans

2.3 Mangroves

2.4 Marine eutrophication

UNIT III: MARINE POLLUTION AND RECLAMATION15 L

3.1 Impact of anthropogenic activities:

A)a) Pollution- Domestic sewage, industrial/heavy metals.
Agricultural- fertilizers and pesticides.

b) Oil pollution.

c) Ocean dumping.

d) Radioactive and Thermal waste.

B) Reclamation.

C) Ocean Acidification

D) Impacts of Global Warming

UNIT IV: BIOLOGICAL RESOURCES 15 L

4.1 Resources from the sea:

A) Mineral resources:

a) Continental margin.

b) Deep sea mud oozes and manganese nodules.

c) Oil, gas and sulphur deposits and role of ONGC.

B) Bioactive compounds from the sea.

C) Scientific and economical aspect of seabed exploration and mining.

***marked topics are to be taken for seminar**

SEMETER – IV

PSZOOCN404: PLANKTOLOGY, FISH, FISHERY SCIENCE AND BIOLOGY OF THE OCEAN

Objectives and outcomes:

- Enumerate the methods used in studies of planktons and learn about their relationship with other marine organisms.
- Study the statistical methods widely used in research analysis and also the factors affecting the dynamics of a population.
- Identify the various endogenous rhythms in the oceans and discuss the types of reproduction and larvae found in marine organisms.

UNIT I: PLANKTOLOGY 15L

1.1.Marine algae and plankton in relation to fisheries.

Indicator species

1.2. Methods of collection, preservation and analysis of plankton.

1.3. *Marine Bio-deterioration: Fouling and Boring organisms.

UNIT II: FISH AND FISHERIES SCIENCE 15L

2.1.Population Dynamics

Abundance in population and fishery.

Fishery catches and fluctuation.

M.S.Y., Optimum Yield, Age Composition, Population Growth, Population Models.

2.2. ***Socio-economics of fishermen.**

UNIT III: BIOTECHNOLOGY IN FISHERY AND BIOMETRIC STUDIES 15L

3.1. Statistical methods:

Collection of data, Sampling methods, Presentation data, Measurement of central tendancy and dispersion, Frequency distribution, Analysis of variance and co-variance, Correlation regression, Theory of probability, Tests of significance, Chi-square test.

3.2. * Measurement of fish:

a) Measurement of length and weight

b) Morphometric measurements

c) Merestic counts

UNIT IV: BIOLOGY OF THE OCEAN 15L

4.1. Endogenous rhythms : biological clocks, lunar periodicity and tidal rhythms.

4.2. Sense Organs: types of organs and their functions

4.3. General account of reproduction in marine organisms.

4.4. General account of different types of larvae in Crustacea, Mollusca, Echinodermata and Teleosts

***marked topics are to be taken for seminar**

SEMESTER IV PRACTICALS

PSZOOCN4P3 Based on PSZOOCN403 andPSZOOCN4P4

1. Oceanographic instruments:

a) Nansen reversing bottle.
b) Deep sea reversing thermometer.
c) Bathythermometer.
d) Drift bottle.
e) Ekman's current meter.
f) Secchi disc.
g) Plankton nets: Standard net, Hensen net and Clarke Bumpus net.
h) Stemple pipette and counting slide.
i) Nekton sampling device-trawls.
j) Benthic sampling devices-dredges, grabs and corers.

2. Detection of heavy metals:

a) Zinc
b) Lead
c) Copper**.**

3. Food and feeding in fish.
4. Preparation of Zooplankton mountings.

5. Biometric studies of fish/ prawn

A. Study of relationship between total length and standard length/head length/body depth length/body weight.

B. Calculate correlation (standard length and total length, head length and total length, body depth and total length). Calculate the index values for various relationships.

6. Identification of fouling and boring organisms

(*Limnoria*sps., *Lepas, Balanus, Caprella, Teredo, Littorina, Crassostrea, Pellaria/ Sertularia*).

7. Identification and classification of fresh water fishes

Rohu, Catla, Mrigal, Tilapia, Gourami and fresh water giant prawn (*Macrobrachiumrosenbergii*).

8. Crustacean fishery

(*Penaeus monodon, P. indicus, M.monoceros, P. stylifera, Solenoceraindica, Nematopaleomon, Acetes indicus*).

9. Molluscan fishery

(*Meretrix, Pernaviridis, Katelysiasps., Crassostriasps., Xancuspyrum, Solenkempi, Cuttle fish* and gastropods).

Semester III & IV

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