MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE GANESHKHIND, PUNE-16
(AUTONOMOUS)

SYLLABUS OF FIRST YEAR M.Sc. ZOOLOGY

M.Sc – I (SEMESTER I AND II)

(SECOND REVIEW)

To be implemented from Academic Year

2025-2026

FRAMED BY

BOARD OF STUDIES IN ZOOLOGY

Progressive Education Society's
MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE, GANESHKHIND, PUNE- 16
(AUTONOMOUS)

PREAMBLE:

Zoology is a major subject of Basic Sciences which deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. The advancements in biological Sciences demands a zoology student to be a master of many areas in the subject. This Postgraduate degree program has been designed by the Board of Studies in Zoology with a tangible understanding of what is needed from zoologists and what zoologists need to pursue as a skilled career. It emulates closely the Benchmark Statement for Biosciences and the guidelines laid down by the University Grants Commission, New Delhi. This Newly designed Curriculum is an appropriate blend of the classical aspects in Zoology which has been the "backbone" knowledge required for all zoologists and the recent and specialized areas. The flexibility in the Curriculum allows the students to choose their areas of interest leading to enhanced employability. Students will be provided sufficient number of hours for their skill development through the Lab Courses and the Project component. The lab courses have differing flavours and priorities to make a good zoologist. This degree offers specialization in Entomology along with a range of core courses like Biochemistry, Molecular Biology, Comparative Animal Physiology, Developmental Biology, Environmental Biology etc. The field trip/surveys and study tours are included to give the student an enticing taste of what life is specially outside the walls of the classroom. On successful completion of the programme, the students are expected to understand the key life processes of human and other animal groups, the functioning of molecules, cells, tissues, organs and systems. Also the students will gain increased confidence to use initiative and judgement to make decisions in complex and changeable situations and reflect critically and analytically on personal experience and make informed decisions about further study, training and employment opportunities. The Master of Science (M.Sc.) in Zoology is a Postgraduate program under the Faculty of Science and Technology. The curriculum designed M. Sc. Zoology encompasses subjects like Physiology, Entomology, Genetics, Cell Biology, Developmental Biology, Endocrinology, Biochemistry, Molecular Biology, Freshwater Zoology, Environmental Biology etc. Both classical and applied subjects of Zoology have been rightly blended to offer holistic understanding of the subject. The Choice Based Credit System (CBCS) will be implemented through this curriculum. This curriculum would certainly felicitate students to develop a strong base of the fundamentals and specialize in the desired area of their fondness and abilities. The students pursuing this program would get a privilege to select optional subjects of their choice. This curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent

thinking and problem-solving skills.

Instructions for the Students:

The students seeking admission to M.Sc. Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.

2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.

3. The students opting for dissertation course shall follow the rules framed for the same.

4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

Eligibility:

The candidate should have a B.Sc. degree with Zoology as principal subject or B.Sc. (General) degree with Zoology as one of the subsidiary subjects. Graduates in any life science related subjects such as Biotechnology, Bioinformatics, Life science, Biochemistry, Microbiology, Agriculture, Veterinary sciences, Biology, Botany etc. Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune. Reservation and relaxation will be as per the government rules.

Examination

[A] Pattern of Examination Evaluation of Students:

1) The In-semester and End-Semester examinations will be of 20 marks each for 2 credits and 40 marks for 4 credits and for End-semester 30 marks for 2 credits and 60 marks for 4 credits.

2) Student has to obtain minimum of 40 %marks separately in both the In-Semester and End- Semester.

3) Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.

5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

i. In-semester Examination:

Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a) Theory Courses: Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

a) Multiple choice questions

b) Combination of objective and subjective questions.

c) Open book test (concerned teacher will decide the allowed books)

d) Tutorial

e) Surprise test specified topics in a given notified period

f) Oral

g) Assignments

h) Review of research paper

i) Seminar presentation

j) Journal/Lecture/Library notes Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) Practical Courses:

It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.

2. Assessment on practical course be conducted before the end-semester examination.

3. Assessment of each experiment shall be done for each practical weekly.

4. Assessment of the Activity will be based on any one of the following (per practical course).

i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.

ii. Project on Research Methodology

iii. Industrial/Institution Visit report

iv. Field visit report/ study tour report.

The student strength of practical batch should be 12

Project Course: Project will be evaluated by the examiner/s in consent with the project guide if required.

ii. End-Semester Examination:

The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

[B] Standard of Passing

Student has to obtain 40% marks separately in In-Semester and End-Semester assessment.

Program outcomes (POs):

After successfully completing the M.Sc. Zoology program students will be able to:

PO1. **Zoology knowledge**: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.

PO2. **Problem analysis**: Identify, review research literature, and analyse complex situations of living forms.

PO3. **Design/development of solutions**: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

Programme Specific outcomes

PSO1: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

PSO2: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

PSO3: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Structure with Credit Distribution of the Postgraduate Science Program in Zoology- M.Sc in Zoology under NEP to be implemented from 2025-2026

M.Sc First year Zoology

Course type	Course code	SEMESTER I	Course Code	SEMESTER II	Credits
Mandatory major	**ZOO51101**	Biochemistry and Biotechniques (4C) (T)	**ZOO52101**	Molecular Biology and Bioinformatics(4C) (T)	4+4
Mandatory major	**ZOO51102**	Cell and Developmental Biology (4C) (T)	**ZOO52102**	Endocrinology and Comparative Animal Physiology (4C) (T)	4+4
Mandatory major	**ZOO51103**	Advanced Genetics (2C) (T)	**ZOO52103**	Parasitology (2C) (T)	2+2
Mandatory major	**ZOO51104**	Scientific Communication (2C) (T)	**ZOO52104**	Toxicology(2C) (T)	2+2
Mandatory Major	**ZOO51105**	Practicals in Biochemistry, Biotechniques, Advanced Genetics and Scientific Communication (2C) (P)	**ZOO52105**	Practicals in Molecular Biology, Bioinformatics, Parasitology and Toxicology (2C) (P)	2+2
Major elective	**ZOO51106**	Environmental Biotechnology (2C) (T)	**ZOO52106**	Fishery Science(2C) (T)	2+2
Major elective	**ZOO51107**	Practicals in Cell, Developmental Biology and Environmental Biotechnology (2C) (P)	**ZOO52107**	Practicals in Endocrinology, Comparative Animal Physiology and Fishery Science (2C) (P)	2+2
RM	**ZOO51208** **ZOO51209**	Research Methodology (2C) (T) Practicals in Research Methodology (2C) (P)		--	2+2
RP			**ZOO52608**	**OJT/FP- 4C**	4
				Total credits:	**44**
EXIT OPTION: PG Diploma (40-44 credits) After three year UG Degree					

Abbreviations: RM- Research methodology; OJT- On job training; RP- Research project; FP- Field project

Course Code: ZOO51101						
Course Title: Biochemistry and Biotechniques (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 1 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Biochemistry Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Define basic terms in biochemistry and biochemical techniques.

CO2: Explain the applications of the various biochemical techniques.

CO3: Explain the structure and functions of various biomolecules.

CO4: Explain the importance of biomolecules with in biological systems.

Biotechniques Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Explain the importance and applications of techniques in biochemistry.

CO2: Explain the principle and applications of various techniques with examples.

CO3: Explain the principle, working, materials used and applications of electrophoresis.

CO4: Describe the concept of light, electromagnetic spectrum and its application in absorption spectroscopy.

CO5: Illustrate the importance of radioactive compounds and radioactivity in biology.

CO6: Demonstrate the principle, working, applications of centrifugation.

Biochemistry:

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Biochemistry- Definition, scope and applications** 1.1 Basics of chemistry- Structure of atoms, molecules and chemical bonds 1.2 Normality, molarity, molality	(02L)
2	**Unit 2: Introduction to Biomolecules- Carbohydrates and their metabolism** 2.1 Basic Structure, Classification and properties of monosaccharides, oligosaccharides and polysaccharides. 2.2 Clinical and Biological Significance. 2.3 Glycolytic pathway; regulation of the hexokinase, phosphofructokinases. 2.4 Kreb's cycle; amphibolic nature of TCA cycle. 2.5 Glyoxylate cycle, regulation of glycogen metabolism, gluconeogenesis and its regulation, pentose phosphate pathway.	(07L)
3	**Unit 3: Introduction to Biomolecules: Lipids and their metabolism** 3.1 Basic structure, properties and Classification. 3.2 Clinical and Biological significance. 3.3 Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol. 3.4 Composition and synthesis of lipoproteins and their transport in the body, oxidation of fatty acids (beta & alpha), oxidation of long chain fatty acids. 3.5 Regulation of fatty acid synthesis, cholesterol metabolism and its regulation.	(07L)
4	**Unit 4: Introduction to Biomolecules: Amino acids and Proteins** 4.1 Basic structure and classification. 4.2 Physical properties- Optical Isomerization, Absorption in UV light, Ionization. 4.3Chemical properties- Reactions with carboxyl group and amino group. 4.4 Peptide bond formation and Protein structures- Primary, Secondary, Tertiary and Quaternary with examples. 4.5 Ramachandran plot.	(07L)

	4.6 Clinical and Biological significance. 4.7 Protein folds and motifs, domains and domain swapping, protein symmetry, prokaryotes and mammalian molecular chaperons.	
5	**Unit 5: Enzymes** 5.1 Classification, nomenclature and properties. 5.2 Enzyme kinetics -one substrate reaction (Michaelis-Menten Equation). 5.3 Factors affecting enzyme activity. 5.4 Enzyme inhibition. 5.5 Allosteric Enzymes. 5.6 Isozymes (LDH) and coenzymes. 5.7 Clinical and industrial significance.	(07L)
	Biotechniques	
Sr. No.	**Name of the Unit**	**Lectures alloted**
1	**Unit 1: Chromatography** Principle, working and applications of: 1.1 Adsorption chromatography. 1.2 Partition chromatography. 1.3 Ion-exchange chromatography. 1.4 Molecular exclusion chromatography. 1.5 Affinity chromatography. 1.6 Gas chromatography. 1.7 High Performance Liquid Chromatography.	(07L)

2	**Unit 2: Electrophoresis** 2.1 Support media. 2.2 Electrophoresis of proteins and nucleic acids. 2.3 Isoelectric focusing.	(04L)
3	**Unit 3: Absorption spectroscopy** 3.1 Concept of light and electromagnetic spectrum. 3.2 Ultraviolet and Visible spectrophotometry. 3.3 Atomic absorption spectrometry and its applications.	(04L)
4	**Unit 4: Radioactivity** 4.1 Properties of radioisotopes. 4.2 Structure &working of G.M counter. 4.3 Isotopic dilution analysis. 4.4 Use of isotopes in biology and Radiation hazards.	(04L)
5	**Unit 5: Introduction to microscopy** 5.1 Bright field and Dark field. 5.2 Concept of phase differences, Phase contrast microscopy, Differential Interference contrast (Nomarsky) microscopy, Fluorescence Microscopy.	(04L)
6	**Unit 6: Methods for protein sequencing** 6.1 N-terminal sequencing. 6.2 C-terminal sequencing. **Methods for DNA sequencing** 6.3 Maxam- Gilbert sequencing. 6.4 Chain termination method. 6.5 Dye terminator sequencing.	(04L)
7	**Unit 7: Centrifugation** 7.1 Principle, Types of centrifugation-Preparative and Analytical. 7.2 Applications of centrifugation.	(03L)

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1. Biochemistry, 3rd Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
2. Biochemistry 6th Ed, (2007) Berg Jeremy, Tymoczko John, StryerLubert, Publisher: W. H. Freeman, New York.
3. Lehninger's Principles of Biochemistry, 4th edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
4. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
5. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
6. Biochemistry, Geoffrey Zubay, William C Brown Pub; 4th edition (June 1999)
7. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition (2008), Keith Wilson and John Walker, Publisher–Cambridge University Press
8. Light Microscopy in Biology: A Practical Approach, 2nd edition (1999), Alan
J. Lacey, Publisher–Oxford University Press.
9.Electron Microscopy: Principles and Techniques for Biologists, (1992), Lonnie
10. D. Russell, Publisher-Jones & Bartlett

Course Code: ZOO51102						
Course Title: Cell Biology and Developmental Biology (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 2 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Cell Biology Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Describe the structure and functions of the prokaryotic and eukaryotic cell.

CO2: Highlight the ultrastructure and functions of various types of cell organelles. CO3: Explain the concepts of cell signaling.

CO4: Explain the concept of Protein Trafficking.

CO5: Illustrate the chemistry and organization of cytoskeleton.

CO6: Diagrammatically represent the cell cycle phases and its regulation.

Developmental Biology Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Define the terms in developmental biology.

CO2: Explain the significance of model organism for developmental studies.

CO3: Explain the types of eggs, concept of fertilization.

CO4: Explain the concept of mesoderm induction and pattern formation with examples.

CO5: Describe neural competence and induction.

CO6: Explain the concept of growth and differentiation.

Cell Biology:

Sr.No.	Name of the Unit	Lectures alloted
1	**Unit 1**: **Introduction to Cell Biology** 1.1 Definition and Scope of Cell biology. 1.2 Cell Theory. 1.3 Overview of Cell Types.	(02L)
2	**Unit 2: Plasma membrane** 2.1 Ultrastructure- Fluid Mosaic Model, Membrane proteins: channels, carriers and pumps. 2.2 Membrane transport- Active, Passive,BulkTransport. 2.3 Membrane potential.	(05L)
3	**Unit 3: Nucleus** 3.1 Ultrastructure – nuclear envelope, nuclear lamina, nuclear pore complex, nucleolus. 3.2 Functions of Nucleus	(02L)
4	**Unit 4: Endomembrane system** 4.1 Endoplasmic reticulum, Golgi complex, Lysosomes- Structure and Function. 4.2 Protein trafficking – secretory and endocytic pathways.	(06L)
5	**Unit 5: Mitochondria** 5.1 Structure, function. 5.2 Protein import.	(03L)
6	**Unit 6: Cytoskeleton** 6.1 Types and Organization. 6.2 Role of Cytoskeletal Proteins.	(03L)
7	**Unit 7: Cell Cycle** 6.1 Phases, check points, mechanism of regulation. 6.2 Regulators of cell cycle progression – MPF, cyclins and cyclin dependent kinases (CDKs).	(05L)

8	**Unit 8: Cell signalling** 8.1 Signalling molecules and their receptors. 8.2 Cell surface receptors. 8.3 Signalling through G-protein coupled receptors. 8.4 Secondary messengers.	(04L)
	Developmental Biology	
Sr. No.	**Name of the Unit**	**Lectures alloted**
1.	**Unit1: Basic concepts of development** 1.1 Concepts of Developmental biology –Growth, Potency, Stemness, commitment, specification, induction, competence, determination and differentiation, Cryptobiosis.	(03L)
2.	**Unit 2: Model Organisms** 2.1 Invertebrate: Drosophila melanogaster.	(02L)
3	**Unit 3: Gametogenesis** 3.1 Spermatogenesis: spermatogenesis, structure of sperm, regulation of sperm motility. 3.2 Oogenesis: previtellogenesis, Vitellogenesis and post- Vitellogenesis, Structure of ovum.	(04L)
4	**Unit 4: Fertilization** 4.1 Concept of fertilization, types of fertilization. 4.2 Species specific sperm attraction, recognition of egg & sperm. 4.3 Acrosome reaction. 4.4 Prevention of polyspermy: Fast block & Slow block.	(04L)
5	**Unit 5: Morphogenesis** 5.1 Blastulation: Frog, Mid Blastula Transition. 5.2 Gastrulation: Frog. 5.3 Neurulation: Frog. 5.4 Organogenesis: vulva formation in *Caenorhabditis elegans*, eye lens induction.	(06L)
6	**Unit 6: Pattern formation** 6.1. Setting up Animal-vegetal and Dorso-Ventral axis in Amphibians. 6.2 Antero-posterior axis: *Drosophila*-role of bicoid, nanos, hunchback.	(04L)
7	**Unit 7: Regeneration**	(04L)

	7.1 Definition and Types- Epimorphosis and Morphallaxis. 7.2 Limb regeneration in *Salamander*. 7.3 Regeneration in Hydra.	
8	**Unit 8: Growth and post embryonic development** 8.1 Apoptosis. 8.2 Aging and senescence.	(03L)

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Cell Biology:

1. Karp Gerald (2010) *Cell Biology*. 9th Edition, John Willey & Sons (Asia) Pt. Ltd.
2. Cooper Geoffrey M. (1997) *The Cell: A Molecular Approach*. ASM Press, Washington D.C., U.S.A.
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5. Alberts B., A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2008) *Molecular Biology of the Cell*. 6th Edition, Garland Science, New York, U.S.A.
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7. De Robertis E. D. P. and De Robertis E. M. E. (1987) *Cell and Molecular Biology*. 8th Edition, Lea and Febiger, Philadelphia.
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Developmental Biology:

1. Developmental Biology, 9th edition (2010), S.F. Gilbert. Publisher –Sinauer, Associates Inc.
2. Principles of Development, 6th edition (2007), Lewis Wolpert, Publisher- Oxford, University Press.
3. An Introduction to Embryology, 5th edition (2004), B. I. Balinsky. Publisher – ThomasAsia Pvt. Ltd.
4. *Developmental Biology*, (2001), R. M. Twyman, Publisher - Bios Scientific, Publishers LTD.
5. Analysis of Biological Development , 2000, Klaus Kalthoff, McGraw-Hill Science/Engineering/Math; 2nd Ed edition.

Course Code: ZOO51103						
Course Title: Advanced Genetics (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 3 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Understanding the pre-Mendelian genetic concepts, their principles and gene interaction.

CO2: To study the mechanism of sex determination in different organisms.

CO3: Knowledge about the basic understanding on human genetics and hereditary.

CO4: Explain the concept of qualitative and quantitative genetics.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Introduction** 1.1 Scope of Genetics and Practical applications of genetics in brief.	(02L)
2	**Unit 2: Recapitulation of Mendelian principles; Mendel and his work** 2.1 Mendelian principles.	(02L)
3	**Unit 3: Classical concept of a gene** 3 1 Allele, pseudoalleles, multiple alleles (blood groups).	(02L)
4	**Unit 4: Extensions of Mendelian principles** 4.1 **Gene** interactions and epistasis and their types.	(02L)
5	**Unit 5: Linkage and crossing over** 5.1 **Linkage**, linkage groups, types of crossing over, sex linkage, sex limited and sex influenced characters. 5.2 Recombination, recombination maps in diploids for 2	(06L)

	point and 3-point test cross, (determination of gene order with suitable examples).	
6	**Unit 6: Quantitative genetics** 6.1 Polygenic inheritance, heritability and its measurements 6.2 Quantitative Traits Locus mapping.	(03L)
7	**Unit 7: Somatic cell genetics and its applications.**	(02L)
8	**Unit 8: Principles of Population Genetics** 8.1 Hardy-Weinberg law and its application for autosomal genes. 8.2 Calculations of gene frequencies with suitable examples.	(05L)
9	**Unit 9: Microbial genetics** 9.1 Methods of genetic transfers – transformation, conjugation, transduction.	(03L)
10	**Unit 10: Extra chromosomal inheritance** 10.1 Inheritance of Mitochondria.	(01L)
11	**Unit 11: Human genetics** 11.1 Dominant and recessive disorders, physical traits.	(04L)

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2. Principles of Genetics,Gardner, E.J., Peter & Simmons, M.J. and Snustad, D.P. 8 thEdn.John Wiley and Sons, New York, 2006.
3. Concepts of Genetics. William S Klug and Michael R Cummings. 10thEdn. Pearson Education India, 2016.
4. Lewin, Benjamin. Genes IX. John Wiley and Sons, New York,2008.
5. Genetics By Verma,PS. And Agrawal, VK., S.Chand and Co.,New Delhi
6. Genetics By Gupta, PK., Rastogi Publication, Meerut
7. Genetics By Sarin,C., Tata McGraw Hill,New Delhi
8. Genetics: Daniel J Fairbanks, W. Ralph Andersen; Brooks / Cole Publ. co. (1999).
9. iGenetics: A Molecular Approach, 3rdEdn by Peter J Russell, Pearson India, 2016, Paperback

Course Code: ZOO51104						
Course Title: Scientific Communication (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 4 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Describe the meaning, importance and relationship of language.

CO2: Students will be able to understand the organization of English language and common errors in written and spoken English.

CO3: Students will be able to understand the steps of make an oral presentation and effective ways to deliver it.

CO4: Students will be able to draft the research project for funding agencies.

CO5: Students will be able to understand the language of scientific paper and write the research paper.

CO6: Students will be able to do editing, prof-reading and plagiarism check of scientific research papers.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Language as a communication tool** 1.1 Relationship of language among reading, writing, listening and speaking.	(02L)
2	**Unit 2: Pragmatic competence: co-operative principles and politeness principles Introduction of Scientific Writing** 2.1 Introduction, Meaning, Language of a Scientific Paper	(03L)
3	**Unit 3: Organisation of English language** 3.1 Sentence structure, basic grammar, sequence and tenses, syntax, 3.2 Paragraphs, paraphrases and précis writing	(03L)

	3.3 Synonyms and antonyms.	
4	**Unit 4: Common errors in written and spoken English** 4.1 Tautology, double negative, double positive, superfluous words	(02L)
5	**Unit 5: Oral presentation** 5.1 How to prepare a presentation, power point slides, use of communication and Information technology. 5.2 Voice, speed of delivery, obstacles in effective communication.	(02L)
6	**Unit 6: Outline of research project proposal writing** 6.1 Drafting of a research project for financial assistance from funding agency. 6.2 Writing of scientific paper using word processor.	(02L)
7	**Unit 7: Outline of a scientific research paper** **Outline 1:** 7.1 Hypothesis, theory and concept. 7.2 Title designing, framing Abstract and Keywords. 7.3 Introduction: statement of the problem and justification; aim, objectives, need, significance and rationale of the study, review of literature. 7.4 Materials and Methods: contents, importance of measurements, reproducibility etc. **Outline 2:** 7.5 Observations and Results: text and data presentation, tables, graphs, histograms, diagrams, photographic plates, legends and captions. 7.6 Discussion: logical sequence and critical analysis of ideas and evidences, data conclusion. 7.7 References: finding references from journals, books and databases; Citation - styles of citations. 7.8 Summary, Acknowledgements.	(5L) (5L)
8	**Unit 8: Editing and correcting**	(03L)

	8.1 Proof-reading symbols, jargons and abbreviations.	
9	**Unit 9: Plagiarism** 9.1 Meaning, types, avoiding plagiarism.	(03L)

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1. O'Conner M. and F. P. Woodford (1975) Writing Scientific Papers in English. Elsevier- ExcerptaMedica-North Holland Publ., Amsterdam.
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Course Code: ZOO51106						
Course Title: Environmental Biotechnology (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Major elective	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 6 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Describe various components of environment.

CO2: Explain types of pollution and associated pollutants.

CO3: Describe waste water treatment process.

CO4: Discuss bioremediation technology and its global perspective.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Components of Environment and Global Environmental Problems** 1.1 Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples. 1.2 Interaction of man and environment; Environmental Studies as a multidisciplinary subject. 1.3 Green House Effect, Acid rain, El Nino Effect, Ozone depletion, Biodiversity loss; chemical and radiation hazards.	(08)
2	**Unit 2: Environmental pollution and Environmental Management** 2.1 Pollution of air, water, land and noise (Causes, nature of pollutions, impact and control strategies). 2.2 Environmental Impacts by agricultural practices. 2.3 Habitat Pollution by Chlorinated Hydrocarbons (DDT, PCBs, Dioxin etc.), Organophosphates, Heavy Metals, Endocrine disrupting chemicals, Nutrient pollution. 2.4 Environmental Management – Concept of grey water, health and sanitation. 2.5 Environmental diseases – infectious (Water and air borne) and pollution	(10)

	related, spread and control of these diseases, health hazards due to Pesticide and metal pollution. 2.6 Waste treatment, solid waste management, environmental standards and quality monitoring. 2.7 Role of EPA and its guidelines.	
3	**Unit 3: Waste water treatment and management** 3.1 Domestic Waste Water Treatments: Primary, Secondary and Tertiary. 3.2 Important microorganisms in waste water treatment. 3.3 Waste water treatment Reactors: Introduction and types in brief. 3.4 Aerobic Biological Treatments: Activated sludge process, Lagoons. Aerobic biofilm processes- Trickling filter and biological towers, 3.5 Anaerobic Biological Treatments: up flow anaerobic sludge blanket (UASB) reactor, Fluidized bed reactors	(06)
4	**Unit 4: Biodegradation and Bioremediation** 4.1 Biodegradation: Definition and Concept, Aerobic and Anaerobic degradation pathways in Microbes. 4.2 Biodegradation of Hydrocarbon with Suitable Examples. 4.3 Xenobiotics biodegradation-pesticide biodegradation with suitable example. 4.4 Bioremediation: Introduction, Definition and Concept, Methods of Bioremediation (In Situ and Ex Situ Methods). 4.5 Phytoremediation: Concept and Types.	(06)

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1. Environmental Biotechnology: Theory and Applications (2003), Evan G. M. and Furlong J.C, John Wiley and Sons Ltd., England.
2. Environment: Problems and Solutions (2001), Asthana D.K. and Asthana M., S. Chand and Company Ltd, New Delhi.
3. Introduction to Environmental Biotechnology (2004) Chatterji A.K. Prentice Hall of India Pvt. Ltd, New Delhi.
4. Environmental Biotechnology (2006),3rd Edi. Jogdand S.N., Himalaya Publishing House, Mumbai.
5. Environmental Science and Biotechnology: Theory and Techniques (2005). Murugesan A. G. and Rajkumari., C, MJP Publishers, Chennai.
6. Environmental Biotechnology Principles and Applications. (2001) Rittmann B. E. And

McCarty P. L, McGraw Hill, USA

7. Waste water engineering and management (1972) Eddy and Metcalf Tata Mac Graw-Hill.

Course Code: ZOO51105						
Course Title: Practicals in Biochemistry, Biotechniques, Advanced Genetics and Scientific Communication						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 5 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Practicals in Biochemistry, Biotechniques		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Preparation of Acid & Alkali solutions, acid-base titration and calculation of pKa values.	1P
2	Units and specific activity of enzymes and study of effect of substrate concentration on enzyme activity.	1P
3	Determine the concentration of Vitamin C by titration method from various sources.	1P
4	Estimation of Sugar (Glucose) by Folin Wu method.	1P
5	Estimation of protein by Bradford method**.**	1P
6	To study the principle and working of High-Performance Liquid Chromatography.	1P

Practicals in Advanced Genetics		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Setting of Drosophila culture and study of its lifec cycle.	1P
2	Study of monohybrid and Dihybrid ratio in *Drosophila sp.*	1P
3	Determination of gene distances and gene order for a given three-point test cross.	1P
4	Polytene chromosomes of *Drosophila or Chironomous*- examination of puff and bands.	1P
5	Estimation of allelic frequencies, heterozygote frequencies in human populations.	1P
	Practicals in Scientific Communication	
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Spoken English: English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, pronoun, pronunciation, diphthong, accent, clarity, speed, punctuation, simplicity and syntax, paraphrasing and precis writing, synonyms, antonyms, abbreviations.	2P
2	Oral presentation: Rhythm, style, control, mock presentation of 10 minutes.	1P
3	Common errors in written and spoken presentation- Tautology, double negatives and double positives, sequence and tenses, ambiguity, spellings, jargons.	1P
4	Structure of scientific paper: IMRAD format	2P
5	Study of proof correction symbols; proof- reading the given text & correcting the proofs.	1P

REFERENCES:

1) Biochemistry- : Geffrey L. Zubey.

2) Biochemistry- : Lubert Strayer and W.H. Freeman

3) Biophysical chemistry- : Upadhyay. Upadhyay. Nath.

4) Principles and techniques of biochemistry and molecular biology - : Keith Wilson and John Walker.

5) Advanced Genetics. G. S. Miglani. Alpha Science International, Ltd. 2012.

6) Cell and Molecular Biology, 4th Edition, P.K. Gupta. 2014

7) Fundamentals of Biostatistics. 2nd Edition. Khan & Khanum. 2004. Ukaaz publications.

8) Genes- IX, 9th Ed., Benjamin Lewin. Jones and Bartlett Publishers, 2008.

9) Genetics – Classical to modern, 1st Edition. P.K. Gupta. 2013.

10) Principles of Genetics, 7th Edition, Robert H. Tamarin. 2002. Tata- Mc Graw Hill publications.

11) Theory and Problems of Genetics. W. D. Stansfield. 2002. Mc Graw Hill publications.

12) Technical Communication- Raman & Sharma- Oxford

13) Technical Communication: A Reader centered approach, Anderson Thomson

14) English Grammar & Composition- Pal & Suri- S. Chand

15) Course in Technical English- Somaya Publication

16) A Practical English Grammar – A.J. Thomson A.V.Martinet

Course Code: ZOO51107						
Course Title: Practicals in Cell, Developmental Biology and Environmental Biotechnology						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type Major elective	**Credits**	**Number of Teaching hours**	**Practials per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 7 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Practicals in Cell Biology, Developmental Biology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Study of ultrastructure of cell organelles and types of cells.	1P
2	Temporary preparation of human cheek epithelial cells.	1P
3	Study of different stages of mitosis in suitable material.	1P
4	Study of meiosis in Grasshopper testes / Onion flower buds / *Aloe vera* with emphasis on all stages of prophase.	1P
5	To study the Cell Viability Test using Trypan Blue method.	1P
6	Mounting of chick embryos by Filter Paper ring method and preparation of permanent mounts.	1P
7	Gross Histology of T.S passing through lens, Heart and brain (18, 24, 36, 48 and 96 hrs).	2P
8	Gross anatomy and histology of chick embryo upto 96 hrs. Brain, heart, lens, ear development.	1P
9	Study of embryonic and post-embryonic development using frog egg as a model system**.**	1P
10	Study of regeneration in hydra/ Planaria.	1P

Practicals in Environmental Biotechnology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	A visit to aquatic ecosystem and methods for water and plankton collection and identification.	2P
2	Vegetation studies by line, quadrates and belt transect methods and their analysis.	2P
3	Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples**.**	2P
4	Estimation of BOD and COD in polluted water samples.	1P
5	Analysis of pesticide residue/ contaminants from the given sample using Atomic Absorption Spectroscopy.	1P
6	A Visit to Effluent Treatment plant.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO51105: Practicals in Biochemistry, Biotechniques, Advanced Genetics and Scientific Communication

(2C) (P)

ZOO51107: Practicals in Cell, Developmental Biology and Environmental Biology (2C) (P)

https://swayam.gov.in/

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1. Cooper, G.M., Hausman, R.E. (2019) The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
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3. Gilbert, SF (2014) Developmental Biology (10th edition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. ISBN : 9780878939787
4. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
5. Freeman and Bracegirdle (1975, 2nd Edition) "An Atlas of Embryology", Published by Heinmann
6. De Robertis, E.D.P. and De Robertis, E.M.F. (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins, Philadelphia.
7. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc
8. Kalthoff Klaus (2001) Analysis of Biological Development, 2nd ed. Boston, MA: Mc Graw-Hill, ISBN : 0071180788
9. Wolpert, L & Tickle, C (2011) Principles of Developmental Biology (4th edition). Oxford University Press, ISBN: 9780198792918

Course Code: ZOO51208						
Course Title: Research methodology (Theory)						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type RM	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 1 (under vertical 2)	**02**	**30**	**02**	**20**	**30**	**50**

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Demonstrate knowledge of research processes (reading, evaluating, and developing)
CO2: Perform literature reviews using print and online databases.
CO3: Select and define appropriate research problem and parameters to prepare a project proposal.
CO4: Identify, explain, compare, and prepare the key elements of a research proposal/report.

Sr.No.	Name of the Unit	Lectures alloted
1	**Unit 1: History of research** Indian, Egyptian, Greek ideas methodologies and research in Life sciences Ancient Indian research methodology applications.	(04L)
2	**Unit 2: Foundation of Research** 2.1 Meaning, Objectives, Motivation, Utility, Characteristics and Types. 2.2 Characteristics of scientific methods - understanding the language of Research 2.3 Concept, Construct, definition, Variable. Scientific Research Process. 2.4 Steps of research, methods of research, research ethics. 2.5 Exploratory and confirmatory research 2.6 Methods of data collection and sampling techniques Statistical Analyses and its significance. 2.7 Various software and use of statistical tools for statistical analysis.	(06L)
3	**Unit 3: Problem Identification & Formulation** 3.1 Definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem. 3.2 Literature survey: primary and secondary; web sources; critical literature review. 3.3 Research Question - Investigation Question - Hypothesis testing - Qualities of a good hypothesis - Null hypothesis & Alternative Hypothesis	(03L)
4	**Unit 4: Research Design**: 4.1 Concept and Importance in Research - Features of a good research design 4.2 Exploratory Research Design - Concept, Types and uses 4.3 Descriptive Research Design - concept, types and uses. 4.4 Experimental Design - Concept of Independent &Dependent variables. 4.5 Biased and unbiased research design	(05L)

5	**Unit 5: Qualitative and Quantitative Research** 5.1 Qualitative - Quantitative Research – Concept of measurement, causality, generalization, replication. Merging the two approaches. 5.2 Biological data: Types of data - Qualitative data, Quantitative data	(04L)
6	**Unit 6: Data Collection and analysis** 6.1 Execution of the research - Observation and Collection of data 6.2 Methods of data collection, hypothesis-testing - Generalization and Interpretation.	(03L)
7	**Unit 7: Interpretation of Data and Paper Writing** 7.1 Graphical interpretation of data, Layout of a Research Paper 7.2 Journals- Ethical issues related to publishing 7.3 Plagiarism and Self Plagiarism.	(03L)
8	**Unit 8: Intellectual Property Rights** 8.1 Types, Copyrights in Scientific work, Patents in scientific research, 8.2 Writing a patent specification 8.3 Patent filing and grant, infringement. 8.4 Gene patenting, Traditional knowledge and protection.	(02L)

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1. Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K., 2002. An Introduction to Research Methodology, RBSA Publishers
2. Kothari C. R., 1990. Research Methodology: Methods and Techniques New Age International 418p.

Sinha S. C. and Dhiman A. K., 2002. Research Methodology Ess Publications 2 Columes.

3. Trochim W. M. K., 2005. Research Methods: The Concise Knowledge Base Atomic Dog Publishing. 270P
4. Wadehra B. L., 2000. Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing
5. Research Methodology: An Introduction-Stuart Melville and Wayne
6. Practical Research Methodology-Catherine Dawson
7. Research Methods for Science Michael P Marder Research Methodology: Principle, Methods and Practices-Joshua O.Miluwi and Hina Rashid Gastle
8. Research Methodology: A Step By Step Guide for beginners- Ranjeet Kumar
9. How to Write and publish a Research Paper- Seventh Edition-Robert Day And Barbara
10. Introduction to Biostatistics and Research Methods- P S S Sunder Rao
11. Research Methodology and Scientific Writings- C George Thomas

Course Code: ZOO51209						
Course Title: Practicals in Research methodology						
M.Sc. SEMESTER-I						
Teaching Pattern				**Evaluation Pattern**		
Course Type RM	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 2 (under vertical 2)	**02**	**30**	**02**	**20**	**30**	**50**

Practicals in Research Methodology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Selecting a title for the paper, writing the abstract and key words.	1P
2	Writing the Discussion Conclusions and Results: Citation of references	1P
3	Importance of scientific surveys, primary data and secondary data in research.	1P
4	Writing a project proposal to a funding agency.	1P
5	Use of MS Excel in data presentation.	1P
6	Examples of some common statistical tests.	2P
7	Use of softwares for plagiarism check.	1P
8	Making a ICT enabled scientific presentation.	1P
9	Microscopic techniques.	1P
10	Presentation of any ONE research paper.	1P

REFERENCES:

1. Practical Research Methodology-Catherine Dawson
2. Research Methods for Science Michael P Marder Research Methodology: Principle, Methods and Practices-Joshua O.Miluwi and Hina Rashid Gastle
3. Research Methodology: A Step By Step Guide for beginners- Ranjeet Kumar
4. How to Write and publish a Research Paper- Seventh Edition-Robert Day And Barbara

M. Sc. Zoology (Semester - II)

Course Code: ZOO52101						
Course Title: Molecular Biology and Bioinformatics (Theory)						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 1 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Explain the DNA structure & types, topology, Physical properties; chromatin structure and organization.

CO2: Discuss genome organization, DNA and Protein sequencing with their application in evolutionary studies.

CO3: Explain the mobile DNA elements.

CO4: Explain mechanism of DNA damage and repair.

CO5: Illustrate the process of DNA replication, transcription, translation and their regulations.

CO6: Illustrate the database tools with their significance.

CO7: Apply the knowledge of bioinformatics web resources and databases.

CO8: Study the different sequence alignment tools and methods.

Molecular Biology

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: DNA structure and topology** 1.1 Types of DNA **(A,B,Z).** 1.2 Structure of chromatin, nucleosome. 1.3 Higher order organization - chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin.	(05L)

2	**Unit 2: Physical properties of DNA** 2.1 Tm, hypo and hyper chromicity. 2.2 Solubility, mutarotation and buoyancy**.**	(02L)
3	**Unit 3: Genome organization** 3.1 c- value paradox and genome size. 3.2 Cot curves, repetitive and non-repetitive DNA sequence and their importance. 3.3 Cot ½, kinetic and sequence complexity, satellite DNA, Pseudogenes, Gene families, Gene clusters, Organelle genome.	(04L)
4	**Unit 4: DNA Replication** 4.1 DNA replication in *E. coli.* 4.2 Types of *E. coli* DNA polymerases. 4.3 Origin of replication, , replication process and its regulation. 4.4 Connection of replication to cell cycle. 4.5 Different models of replication for linear and circular DNA replication. 4.6 Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases.	(08L)
5	**Unit 5: DNA damage and repair** 5.1 Different types of DNA damage. 5.2 Different DNA repair systems. 5.2.1 Nucleotide excision repair. 5.2.2 Base excision repair. 5.2.3 M ismatch repair. 5.2.4 Recombination repair. 5.2.5 Nick Translation and SOS Repair.	(05L)
6	**Unit 6: Transcription** 6.1 Transcriptional Unit in prokaryotes and eukaryotes. 6.2 Role and significance of promoter, enhancer, intron, exon, silencer. 6.3 Transcriptional factors, mechanism of prokaryotic gene transcription. 6.4 Type and structure of RNA polymerases. 6.5 Post transcriptional processing: Capping, polyadenylation and splicing in eukaryotes and significance, Ribonucleoproteins (SnRNPs & ScRNPs).	(07L)
7	**Unit 7: Translation** 7.1 Prokaryotic translation – Genetic code, deciphering genetic code.	(07L)

	7.2 Structure of ribosome (prokaryotic and eukaryotic). 7.3 tRNA – structure of tRNA, modified bases of tRNA. 7.4 Activation of tRNA Initiation – role of initiation factors, Shine Dalgarno sequences. 7.5 Elongation – Role of elongation factors. 7.6 Termination – termination codons, role of release factors. 7.7 Fidelity of translation. 7.8 Post translational modifications: Epigenetic modification and role of non-coding RNA's.	
8	**Unit 8: Gene regulation and expression in prokaryotes** 8.1 Lac operon. 8.2 Arabinose operon. 8.3 Trp operon**.**	(03L)
9	**Unit 9: Mobile DNA elements** 9.1 Transposable elements in bacteria. 9.2 IS elements, composite transposons, replicative, non-replicative transposons. 9.3 Mu transposition Controlling elements in Tn A and Tn 10 transposition. 9.4 SINES and LINES. 9.5 Retroviruses and retrotransposon.	(04L)

Bioinformatics

Sr. No.	Name of the topic	Lectures allotted
1	**Unit 1: Introduction** 1.1 Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, ExPASy, PubMed, OMIA). 1.2 Applications of Bioinformatics.	(02L)

2	**Unit 2 :Databases – Tools and their uses** 2.1 Biological databases, Primary sequence databases. 2.2 Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ). 2.3 Protein sequence data bases (UniProtKB, PIR, PDB). 2.4 Secondary sequence databases. 2.5 Derived databases - PROSITE, BLOCKS, Pfam/ Prodom. 2.6 Structure databases and bibliographic databases.	(04L)
3	**Unit 3: Sequence alignment methods** 3.1 BLAST, FASTA. 3.2 Significance of sequence alignment. 3.3 Pairwise sequence alignment (Needleman &Wunsch, Smith & Waterman methods). 3.4 Multiple sequence alignment (PRAS, CLUSTALW).	(04L)
4	**Unit 4: Predictive applications using DNA and protein sequences** 4.1 Evolutionary studies: Concept of phylogenetic trees. 4.2 Parsimony and Bayesian approaches. 4.3 Functional Proteomics: applications of Proteomics. 4.4 Omics: Pharmacogenomics: Discovering a drug: Target identification 4.5 Metabolomics: Concept and applications.	(05L)

REFERENCES:

1. Genes IX, 9th edition (2008), Benjamin Lewin, Publisher - Jones and BarlettPublishers,Inc.
2. Molecular Biology of the Gene, 5th Edition (2004), James D. Watson, Tania Baker,
3. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher -Pearson Education, Inc. and Dorling Kindersley Publishing, Inc
4. Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi& others; CBS Publishing; 2003.

5.Introduction to Bioinformatics; 1st Edition; T K Attwood, D J parry- Smith; Pearson Education, 11th Reprint; 2005.

6. Bioinformatics; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003

7. Bioinformatics sequence and genome analysis; David W. Mount; Cold spring harbor laboratory press;2004

8. Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce S. Lieberman; Wiley-Blackwell; 2011

9. Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well

Publishing; 1998
10. Proteomics - From Protein Sequence to Function; 12 S. R. Pennington, M. J. Dunn; First edition; Springer Publications; 2001
11. Proteomics; Timothy Palzkill; Springer; 2002
12. Metabolomics - A Powerful Tool in Systems Biology; Jens Hřiriis Nielsen, Michael C. Jewett; Springer; 2007
13. Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008
14. Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009
15. A text book of Molecular Biology- J.Pal and S. Ghaskadabi, Oxford Publication- India.

Course Code: ZOO52102						
Course Title: Endocrinology and Comparative Animal Physiology (Theory)						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 2 (under vertical 1)	**04**	**60**	**04**	**40**	**60**	**100**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Understand the fundamental concepts of Comaparative Animal physiology

CO2: Understand mechanisms of various physiological processes such as digestion, respiration, circulation, nervous and muscle contraction

CO3: Learn the effect of environment on physiology of stress.

CO4: Know the structural organization of the endocrine system and how hormones regulate the cellular processes.

CO5: Explain the role of chemical messengers' in communication.

CO6: Study the relation between hormones and reproduction in animals.

CO7: Illustrate how the homeostasis is related to endocrine system in normal physiology.

Endocrinology:

Sr. No.	Name of the topic	Lectures alloted
1	**Unit 1: Introduction of Endocrinology** 1.1 Introduction, Hormones- structure and role as chemical messenger. 1.2 Types of hormones-protein and non-protein.	(02L)
2	**Unit 2: Hormone receptors:** 2.1 Receptors on the plasma membrane, cytoplasm & nucleus.	(02L)
3	**Unit 3: Mechanism of hormone action:** 3.1 Mechanism of hormone action- signal transduction cascade.	(02L)
4	**Unit 4: Endocrine system** 4.1 Hypothalamic hypophysiotropins.	(02L)

5	**Unit 5: Adenohypophysial hormones** 5.1 ACTH, PRL, STH and TSH.	(04L)
6	**Unit 6: Control of chromatophores** 6.1 Pituitary, pineal.	(02L)
7	**Unit 7: Hormonal regulation of carbohydrates, protein & lipid metabolism** 7.1 Pancreatic hormones- glucocorticoids.	(03L)
8	**Unit 8: Osmoregulatory hormones** 8.1 ADH, mineralocorticoids, renin-angiotensin.	(02L)
9	**Unit 9 : Regulation of Gastrointestinal tract** 9.1 Gastrointestinal hormones.	(02L)
10	**Unit 10: Endocrine control** 10.1 Control of calcium and phosphate metabolism.	(02L)
11	**Unit 11: Endocrine mechanism in crustacean** 11.1 X & Y organs. 11.2 Regulation of metabolism. 11.3 Salt and water balance, reproduction. 11.4 Colour change, moulting.	(03L)
12	**Unit 12: Chronobiology** 12.1 Introduction, significance, Clocks, Rhythm and Calendar. 12.2 The biological timing system: Concepts and methods, Types: Ultradian, circadian and circannual rhythms.	(03L)

Comparative Animal Physiology:

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Digestion** 1.1 Digestive system**:** Physiology of digestion and absorption.	(03L)
2	**Unit 2: Respiration** 2.1 Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. 2.2 Blood pigment, role in Oxygen transport. 2.3 O2 dissociation curves physiological and ecological significance, CO2. 2.4 Respiratory system : Comparison of respiration in different species,	(04L)

	anatomical considerations. 2.5 Transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	
3	**Unit 3: Muscle contraction** 3.1 Structure (light & electron microscopic) of the skeletal muscle. 3.2 Proteins of the myofilaments, nature of actin-myosin interaction. 3.3 Sarcoplasmic recticulum and role of Ca++ in contraction.	(04L)
4	**Unit 4: Osmotic regulation** 4.1 Concepts of osmole , osmolarity and tonicity, ionic regulation. 4.2 Hyper-and hypo-osmotic regulators, ureosmotic animals.	(04L)
5	**Unit 5: Excretion, Comparative physiology of excretion** 5.1 Basic processes in urine formation, renal function in animals specially the mammalian kidney. 5.2 Renal pressure system, Comparative biochemistry of nitrogen excretion.	(04L)
6	**Unit 6: Thermoregulation** 6.1 Biokinetic Zones, tolerance and resistance. 6.2 Thermobiological terminologies. 6.3 Compensatory patterns in poikilotherms. 6.4 Critical temp, and zone of thermal neutrality. 6.5 Mechanism of thermoregulation in homeotherms.	(04L)
7	**Unit 7: Chemical Communication** 7.1 Neurosecretion, neuroheamal & endocrine organs.	(03L)
8	**Unit 8: Sense organ** 8.1 Classification & functions (details of photoreception as a model). 8.2 Reflexes, Principles of neural integration.	(04L)

REFERENCES:

1. Bentley, P.J. (1998). Comparative vertebrate endocrinology, edn.3, Cambridge University Press, London.

2. Bollander, F. (1994). Molecular endocrinology, edn.2,Acad. Press, SanDiego.

3. Hadely, M.E. (1996). Endocrinology. Edn.4, Prentice Hall, Upper Saddle Park.

4. Thomdyke, M.C. and Goldsworthy, G.J. (1988). Neurohormones in Invertebrates. Cambridge University Press.

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6. Kobayashi, H. Malsumolo, A. and Ishii, S. (Eds.) (1992).Atlas of endocrine organs: vertebrates and invertebrates. Springer Verlag, Berlin.

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8.Comparative animal physiology, Clifford Ladd Prosser, John Wiley & Sons

9.Animal physiology, Richard W. Hill, Gordon A. Wyse. Harper and Row

10.Comparative animal physiology, Philip Carew Withers, Saunders College Pub., 1992

Course Code: ZOO52103						
Course Title: Parasitology (Theory)						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 3 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Define the terminologies of parasitology.

CO2: Explain the concepts of animal association with examples.

CO3: Describe the role of parasites in public health and hygiene.

CO4: Explain the morphology and life cycle of common parasites.

CO5: Explain the pathogenicity and control measures of common parasites.

CO6: Justify the importance of control strategies against parasitic infections.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: Host-Parasite systems** 1.1 Definitions-Host, vector, Parasite, host-parasite relationship. 1.2 Types of host and parasites. 1.3 Preadaptation to infectiousness. 1.4 Manipulation of Host behaviour, Parasitism & Altruism. 1.5 Transmission: Types, categories: 1.5.1 Conspecific: Contact, Transplacental, Transovarian. 1.5.2 Heterospecific: Mechanical (Indirect & Direct), Biological Paratenic, Hyper parasitic, Parasitoidal. 1.6 Myiasis: Classification according to tissue, vectors specific and accidental; Symptoms, diagnostic, control method prevention, treatment of Myiasis.	(07L)

2	**Unit 2: Type study** 2.1 Classification, geographical distribution, morphology, life-cycle, Transmission, pathogenicity, treatment and prophylaxis of: 2.1.1 Protozoa: *Trypanosoma* Sps, *Leishmania* Sps. 2.1.2 Platyhelminthes: *Schistosoma* Sps., *Echinococcus* Sps 2.1.3 Nematoda: *Ancylostoma* Sps., *Dracunculus* Sps.	(08L)
3	**Unit 3: Mycology** 3.1 General Mycology: Fungus – Classification, Fungal Structure & Morphology. 3.2 Reproduction in fungi 3.3 Normal fungal flora of human beings. 3.4 Immunity to Fungal Infections. 3.5 Diagnostic Mycology - Epidemiology, Pathogenesis, Laboratory Diagnosis of Fungal Infections. 3.6 Specimen collection, preservation, Transportation & Identification of Mycological Agent.	(07L)
4	**Unit 4: Serology & immunodiagnostic methods** 4.1 Serology & antibody synthesis, preparation & demonstration of specific antigens of *Trypanosoma* & *Leishmania.* 4.2 Immunodiagnostic assays, Immunodiffusion, haemogglutination test, Radioimmuno assay, ELISA, complement fixation test.	(06L)
5	**Unit 5: Prophylaxis & control** 5.1 Prophylaxis: meaning and definition. 5.2 Biological, Genetic, Chemical, Physical & Other methods.	(02L)

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1. Arora D.R. and Arora B. (2005).Medical Parasitology. CBS Publishers and Distributors, New Dey N.C., Messrs. (1964). Medical Parasitology, Allied Agency, Calcutta
2. The Ecology of Animal parasites. Unvana Unive of Illinois Press. Baher, et al. (1956).
3. Manual of Parasitic Mites of Medical or Economic Importance. National Pest Control Assoc., Inc., New York. Belding D. L. Mereditch .(1956).

4. Textbook of Parasitology. New York. Cameron T.W.M. and Black A.C.(1934). Internal Parasites of Domestic Animals London.
5. Lapage G., Oliver and Boyd.(1956).Veterinary Parasitology. Edinburgh and London
6. Parija S.C. Review of Parasitic Zoonoses. A.I.T.B.S.Publishers and Distributors, Delhi.
7. Park K. (2003). Text book of Preventive and Social Medicine. Banarsidas Bhanot Publishers Jabalpur, India
8. Subash C. (1996). Text Book of Medical Parasitology. Pariya and All India Publishers & Distributions, Madras Zumpt F., Wasluvjton D.C.(1965).
9. Myiasis in Man and Animals in the Old World. Dauttercvorth

Course Code: ZOO52104						
Course Title: Toxicology (Theory)						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 4 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course Outcomes:

After successfully completing this course, students will be able to:

1. The student will be able to understand OECD and Principals of GLP and Toxicology.
2. The student will be able to understand role and Concepts, and types of Toxicology.
3. The student will be able to understand Design non-clinical toxicity studies and clinical development.
4. The student will be able understand Bioethics, Good Laboratory Practices, General Laboratory Routines of toxicology.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1:- Toxicology** 1.1 Introduction, definition. 1.2 Scope and sub-divisions of toxicology. 1.3 Classification and types of toxins.	(03 L)
2	**Unit 2 :- Introduction to Regulatory Toxicology** 2.1 OECD principles ,GLP Guidelines, CPCSEA,EPA,IBSC 2.2 Schedule Y: Design non-clinical toxicity studies. 2.3 Methods in toxicity testing, dose-response characterization, LD50, LC50	(06 L)

	and EC50. 2.4 Environmental impact: Regulation for biological products. 2.5 Different types of toxicities.	
3	**Unit 3 :- Bioethics and biosafety** 3.1 Ethics moral and laws related to animals. 3.2 Animal welfare requirements. 3.3 Precautions in biological experiments. 3.4 Labeling: Identification, cage cards. 3.5 Handling of experimental animals. 3.6 Disposal of laboratory waste.	(07 L)
4	**Unit 4:- General Laboratory Routine** 4.1 Health checkups, Acclimatization, Grouping, animal marking randomization. 4.2 Common solvents, uses, storage conditions. 4.3 Common toxic symptoms, definitions and observation. 4.4 Body weight, organ weight.	(07 L)
5	**Unit 5:- Good Laboratory Practices (GLP)-** 5.1 Introduction to GLP and its applications, Principles and importance of GLP in research. The fundamental points of GLP- 5.2.1Resources- Organization, personnel, facilities, equipment. 5.2.2 Rules: Protocols, Standard Operating Procedures, concept of the Study Director as the pivotal point of study control. 5.2.3 Characterization: Test items, test systems. 5.2.4 Documentation: Raw data, final report, archives. 5.2.5 Quality assurance: Independent unit from study conduct.	(04 L)

6	**Unit :6- Tools in human health risk assessment** 6.1 Introduction, definition of Toxicokinetics and Toxicodynamics, Toxicogenomics.	(03 L)

REFERENCES:

1. Principles of Toxicology by Karen Stine, Thomas M. Brown
2. Regulatory Toxicology by Shayne C. Gad Taylor & Francis
3. Principles and Methods of Toxicology by A. Wallace Hayes
4. CPCSEA guidelines (http://cpcsea.nic.in)
5. Good Laboratory Practice, 2nd Edition, by Jurg P Seiler, Springer
6. WHO/TDR Manual for Good Laboratory Practice, WHO/TDR, Geneva, Switzerland
7. Robins Basic Pathology, by Saunders, Elsevier
8. Text Book of Pathology, by Harish Mohan, Jaypee
9. Animal bioethics Principles and Teaching Methods, edited by M. Marie, S. Edwards, G. Gandini, M.
10. Handbook of Good Laboratory practices (GLP).

Course Title: Fishery Science (Theory)						
M.Sc. SEMESTER-II						
Teaching Pattern				Evaluation Pattern		
Course Type Major elective	**Credits**	**Number of Teaching hours**	**Lectures per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 6 (under vertical 1)	**02**	**30**	**02**	**20**	**30**	**50**

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Understand the common fishes of India.

CO2: Knowledge of the general characters and evolution of fishes.

CO3: Explain the fish morphology, anatomical modifications and physiology.

CO4: Illustrate the physiology of reproductive and endocrine organs in fish.

CO5: Discuss the signs, symptoms and control measures of common diseases in fish.

Sr. No.	Name of the Unit	Lectures alloted
1	**Unit 1: General characters and Classification of fishes up to orders** 1.1 Major groups of Fishes: Major groups of living Fishes and extinct Fishes – Phylogeny of Fishes.	(02 L)
2	**Unit 2: Gross external anatomy of fishes** 2.1 Skin and its derivatives, scales and their significance. 2.2 Form and function of muscles, gills and gas bladder. 2.3 Skeleton – Endoskeleton – Neurocranium and visceral skeleton.	(02L)
3	**Unit 3: Locomotion in fishes** 3.1 Body form and locomotion, fins and locomotion. 3.2 Migration of fishes, anadromous and catadromous migrations.	(02L)

4	**Unit 4: Fish growth and Age** 4.1 Factors responsible for growth. 4.2 Age and growth relationship.	(02L)

5	**Unit 5: Fish nutrition and digestion** 5.1 Nutritional requirement of fish. 5.2 Different type of feed: Natural and Artificial. 5.3 Anatomy and histology of digestive system and physiology of digestion.	(04L)
6	**Unit 6: Respiratory mechanism** 6.1 Respiratory gills and lungs. 6.2 Accessory respiratory organs: 6.3 Origin of air breathing organs; skin, buccopharynx, opercular cavity and air bladder.	(03L)
7	**Unit 7: Blood vascular system**: 7.1 Circulation of blood, modification in relation to air breathing. 7.2 Circulatory system, heart and accessory pumps.	(03L)
8	**Unit 8: Excretion and Osmo-regulation** 8.1 Structure and function of the excretory organs – Major excretory products of fishes. 8.2 Osmotic and ionic regulation – acid base balance – Patterns of nitrogen excretion.	(03L)
9	**Unit 9: Reproductive system** 9.1 Modes of reproduction, reproductive cycle, structure of gonads and maturity stages, environmental factors controlling reproduction. 9.2 Spawning seasons and grounds, modes of spawning.	(02L)
10	**Unit 10: Nervous system and sense organs:** 10.1 Organization of the central and peripheral nervous systems. 10.2 Olfactory, taste buds, touch receptors, photoreceptors, lateral line and internal ear.	(03L)
11	**Unit 11: Fish pathology** 11.1 Different fish pathogens: Viral, Bacterial, Fungal and Parasitic. 11.2 Different fish diseases: Pathogenic, Nutritional, Parasitic and Environmental.	(04 L)

REFERENCES:

1. Jhingran: Fish and Fisheries of India (1985, Hindustan Publishing Corporation)

2. Khanna and Singh: Textbook of Fish Biology and Fisheries (2003, Narendra Publishing

3. Singh: Advances in Fish Research, Vol. I and II (1993 and 1997, Narendra Publishing House)

4. Srivastava: A Textbook of Fishery Science and Indian Fisheries (1985, Kitab Mahal)

5. Srivastava, Gopalji: Fishes of U.P. and Bihar (2002, Vishwavidyalaya Prakashan)

6. Gupta and Gupta: General and applied Ichthyology (Fish and Fisheries) (2006, Chand)

7. Santhanam: Fisheries Science (1990, Daya Publishing House

8. Cheng, T.C. The Biology of Animal Parasites. Saunders, Philadelphia, 1964.

9. Reichenbach, H.H. Fish Pathology. T.F.H. (Great Britain) Ltd., England, 1965.

10. Conroy, D.A. & R.L. Herman. Textbook of Fish Diseases. Ibid, 1968.

Course Code: ZOO52105						
Course Title: Practicals in Molecular Biology, Bioinformatics, Parasitology and Toxicology						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type Mandatory Major	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 5 (under vertical 1)	**02**	**30**	**01**	**20**	**30**	**50**

Practicals in Molecular Biology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Isolation of bacterial DNA and quantification by UV spectrophotometry and Nanodrop method.	2P
2	Isolation of Liver DNA and quantification, Agarose gel electrophoresis of isolated DNA.	2P
3	Concept of biological database, gene and protein search by BLASTA and FASTA .	1P
4	Construction of phylogenetics tree for DNA and protein.	1P
5	Demonstration of DNA amplification by PCR.	1P

Practicals in Parasitology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Study of life cycle, role as vector & control measures of: Ticks(*Argas, Boophilus*) Mosquito – any two from- *Anopheles/ Aedes/ Culex*	1P

	Any two flies: *Tabanus/ Phlebotomus/ Sarcophaga*.*Cyclops*. (Specimen, Slides or charts may be used.)	
2	Ectoparasites & Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta.	2P
3	Study of life cycle of parasitic protozoa: *Trypanosoma, Leishmania.*	2P
4	Study of life cycle of helminth parasites: *Schistosoma. Echinococcus, Ancylostoma, Dracunculus*	1P
5	Study of Parasites from digestive tract of Cockroach/gut / parasites of hen.	1P

Practicals in Toxicology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Study of types and Basic Principles and applications of Toxicology	1P
2	Study of importance of GLP in toxicology.	1P
3	Study of Oral toxicity and Dermal toxicity	1P
4	Study of Eye irritation/corrosion.	1P
5	Visit to GLP toxicology laboratory.	1P

Course Code: ZOO52107						
Course Title: Practicals in Practicals in Endocrinology, Comparative Animal Physiology and Fishery Science						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type Major elective	**Credits**	**Number of Teaching hours**	**Practicals per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 7 (under vertical 1)	**02**	**30**	**01**	**20**	**30**	**50**

Practicals in Endocrinology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Histology of vertebrate neurosecretory and endocrine structures- T.S. of pituitary, hypothalamus, thyroid, parathyroid and adrenal gland.	1P
2	Histology of the gonands and endocrine regulation of Testes and Ovaries in vertebrates.	1P
3	Study of retrocerebral complex of the cockroach.	1P
4	Study of neurohaemal organs in crustaceans.	1P
5	Effect of epinephrine on chromatophores of fishes.	1P

Practicals in Comparative Animal Physiology		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Study of RBCs in different vertebrates and in different physiological conditions.	1P
2	Study of relation of Body size and oxygen consumption in aquatic animals(crab/fish).	1P
3	Estimation of sugar in human blood and determination of bleeding time and clotting time of human blood.	1P
4	Determination of the heart beat in the crab-effect of temperature & ions and eye stalk ablation on glucose in the haemolymph of the crab.	2P
5	Study of nitrogenous waste products of animals from different habitats**.**	1P

Practicals in Fishery		
Sr. No.	**Name of the Practical**	**Number of Practicals allotted**
1	Study of Digestive and Urinogenital system of suitable locally available fish.	1P
2	Study of Weberian ossicles of *Catla /Labeo.*	1P
3	Study of Gill rakers and Pharyngeal teeth of fishes of different feeding habit.	1P
4	Determination of Relative gut length (RLG) and Gut content analysis.	1P
5	Gonado Somatic index/ Condition factor/Fecundity of *Rohu, Catla, Mrigal*.	1P

Note: It is mandatory for the students to complete a minimum of two courses from the given links and earn the certificate relevant to the Practical courses:

ZOO52105 : Practicals in Molecular Biology, Bioinformatics, Parasitology and Toxicology (2C) (P)

ZOO52107: Practicals in Endocrinology, Comparative Animal Physiology and Fishery Science (2C) (P)

https://swayam.gov.in/

https://nptel.ac.in/

https:// coursera.org/

Course Code: ZOO52408						
Course Title: On Job Training (OJT) (4C)						
M.Sc. SEMESTER-II						
Teaching Pattern				**Evaluation Pattern**		
Course Type OJT	**Credits**	**Number of Teaching hours**	**Sessions per week**	**Internal Assessment**	**End Semester Exam**	**Total**
Subject 8 (under vertical 4)	**02**	**60**	**02/ 03**	**40**	**60**	**100**

Chairman, BOS **Principal**