



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

**Two Year M.Sc. Program in Zoology  
(Faculty of Science)**

**M. Sc. Zoology Syllabus  
Choice Based Credit System Syllabus**

**To be implemented from Academic year 2022-2023**

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

**Title of the Course: M.Sc. (Zoology)****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. Various cross cutting issues relating to Environmental biology have been aptly included to develop the students’ sense towards human wellbeing. 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. [I] 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. A total of 210 hours for theory lectures and 180 hours for laboratory work have been prescribed in each semester including a research project to inculcate the research culture amongst students. 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.

**I. Course Structure with Credit Distribution of the First year M.Sc- Zoology Syllabus**

Semester	Course	Course code	Name of the Course	Credits
I	CCTP	22-ZOUT-111	Biochemistry and Biotechniques	4 Credits (60 L)
	CCTP	22-ZOUT-112	Cell and Developmental Biology	4 Credits (60 L)
	CCTP	22-ZOUT-113	Genetics and Skills in Scientific Communication	4 Credits (60 L)
	CBOP	22-ZODT-114	Biostatistics/ Freshwater Zoology	2 Credits (30L)
	CCPP (22-ZOUT-111 +22-ZOUT-112)	22-ZOUP-114	Zoology Lab- I	4 Credits
	CCPP (22-ZOUT-113 + 22-ZODT-114)	22-ZOUP-115	Zoology Lab-II	2 Credits
	Mandatory credit course	22-50191	Human rights- I	1 Credit
	Mandatory credit course	22-50192	Cyber security- I	1 Credit
Semester II	CCTP	22-ZOUT-121	Molecular Biology and Bioinformatics	4 Credit (60 L)
	CCTP	22-ZOUT-122	Endocrinology and Comparative Animal Physiology	4 Credit (60 L)
	CCTP	22-ZOUT-123	Parasitology and Environmental Biology	4 Credit (60 L)
	CBOP	22-ZODT-124	Bioenergetics/ Ichthyology	2 Credits (30L)
	CCPP (22-ZOUT-121 +22-ZOUT-122_)	22-ZOUP-124	Zoology Lab- I	4 Credits
	CCPP (22-ZOUT-123+22-ZODT-124)	22-ZOUP-125	Zoology Lab-II	2 Credits
	Mandatory credit course	22-50291	Human rights- II	1 Credit
	Mandatory credit course	22-50292	Cyber security- II	1 Credit

**II. Course Structure with Credit Distribution of the Second year M.Sc- Zoology Syllabus**

Semester	Course	Course code	Name of the Course	Credits
<b>III</b>	CCTP	23-ZOUT-231	Entomology	4 Credits (60 L)
	CCTP	23-ZOUT-232	Animal systematics and Research methodology	4 Credits (60 L)
	CCTP	23-ZOUT-233	Insect physiology and biochemistry and Economic Zoology	4 Credits (60 L)
	CBOP	23-ZODT-234	Immunology/ Genetic Toxicology	2 Credits (30L)
	CCPP (23-ZOUT-231+23-ZOUT-232)	23-ZOUP-234	Special Zoology Lab- I	4 Credits
	CCPP(23-ZOUT-233+23-ZODT-234)	23-ZOUP-235	Special Zoology Lab-II	2 Credits
		23-ZOUP245	Research Project	
	Mandatory credit course	23-50392	Cyber security- III	1 Credit
	Mandatory credit course	23-50394	Skill based course	2 Credits
	Mandatory credit course	23-50395	Introduction to Constitution	2 Credits
<b>Semester IV</b>	CCTP	23-ZOUT-241	Advanced Entomology	4 Credit (60 L)
	CCTP	23-ZOUT-242	Mammalian reproductive physiology and Aquaculture	4 Credit (60 L)
	CBOP	23-ZODT-243	Histology and Histochemistry	2 Credit (30 L)
	CBOP	23-ZODT-244	Apiculture	2 Credits (30L)
	CCPP (23-ZOUT-241+23-ZODT-243)	23-ZOUP-243	Special Zoology Lab- III	4 Credits
	CCPP(23-ZOUT-242+23-ZODT-244)	23-ZOUP-244	Special Zoology Lab-IV	2 Credits
	CCPP	23-ZOUP245	Research Project	2 Credits
	Mandatory credit course	23-50492	Cyber security- IV	1 Credit
	Mandatory credit course	23-50494	Skill based course	2 Credits

**Note: 23-ZOUP245 Research Project is a compulsory course to be conducted throughout Semester III and IV, the assessment and evaluation will be done only in Semester IV**

**Course Code and Course Name:****22-ZOUT- 111 Biochemistry and Biochemical Techniques. (4 Credits: 60 Lectures)****Semester I**

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 tools and techniques in biology.

CO5: Illustrate the importance of pH, buffer and water in living systems.

CO6: Illustrate the principle, working and applications of basic techniques used in biology.

CO7: Draw the structures of various carbohydrates and amino acids.

CO8: Classify enzymes with examples.

**Biochemical techniques:**

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

CO2: Explain the principle and applications of various chromatographic 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 and working of Warburg's apparatus.

CO7: Demonstrate the principle, working, applications of centrifugation.

CO8: Justify the applications of radioactivity compounds in biology.

**Biochemistry:**

Sr. No.	Name of the topic	Lectures allotted
1	<b>Module 1: Biochemistry- Definition, scope and applications</b> 1.1 Basics of chemistry- Structure of atoms, molecules and chemical bonds 1.2 Normality, molarity, molality	(02L)
2	<b>Module 2: Chemistry of Water</b> 2.1 Structure of water and physicochemical properties 2.2 Water as an universal solvent	(02L)
3	<b>Module 3: pH and Buffers</b> 3.1 Definition of pH, pH scale 3.2 Henderson- Hasselbalch equation 3.3 Definition of buffer: Biological Buffer System	(03L)
4	<b>Module 4: Carbohydrates</b> 4.1 Basic Structure and Classification 4.2 Properties of monosaccharides, oligosaccharides and polysachharides 4.3 Clinical and Biological Significance.	(03L)
5	<b>Module 5: Lipids</b> 5.1 Basic structure and Classification 5.2 Properties of lipids 5.3 Clinical and Biological significance.	(03L)
6	<b>Module 6: Vitamins</b> 6.1 Classification: water-soluble and fat-soluble 6.2 Clinical and Biological significance.	(02L)
7	<b>Module 7: Amino acids</b> 7.1 Basic structure and classification 7.2 Physical properties- Optical Isomerization, Absorption in UV light, Ionization 7.3 Chemical properties- Reactions with carboxyl group and amino group	(03L)
8	<b>Module 8: Proteins</b> 8.1 Peptide bond formation 8.2 Protein structures- Primary, Secondary, Tertiary and Quaternary with examples 8.3 Ramachandran plot. 8.4 Clinical and Biological significance.	(04L)
9	<b>Module 9: Enzymes</b>	(08L)

	<p><b>9.1</b> Classification, nomenclature and properties</p> <p><b>9.2</b> Enzyme kinetics -one substrate reaction (Michaelis-Menten Equation)</p> <p><b>9.3</b> Factors affecting enzyme activity</p> <p><b>9.4</b> Enzyme inhibition</p> <p><b>9.5</b> Allosteric Enzymes.</p> <p><b>9.6</b> Isozymes (LDH) and coenzymes</p> <p><b>9.7</b> Clinical and industrial significance</p>	
	<b>Biochemical Techniques:</b>	
1	<p><b>Module 1: Chromatography</b></p> <p>Principle, working and applications of:</p> <p><b>1.1</b> Adsorption chromatography</p> <p><b>1.2</b> Partition chromatography</p> <p><b>1.3</b> Ion-exchange chromatography</p> <p><b>1.4</b> Molecular exclusion chromatography</p> <p><b>1.5</b> Affinity chromatography</p> <p><b>1.6</b> Gas chromatography</p> <p>High Performance Liquid Chromatography.</p>	(7L)
2	<p><b>Module 2: Electrophoresis</b></p> <p><b>2.1</b> Support media</p> <p><b>2.2</b> Electrophoresis of proteins and nucleic acids</p> <p><b>2.3</b> Isoelectric focussing.</p>	(4L)
3	<p><b>Module 3: Absorption spectroscopy</b></p> <p><b>3.1</b> Concept of light and electromagnetic spectrum</p> <p><b>3.2</b> Ultraviolet and Visible spectrophotometry</p> <p><b>3.3</b> Atomic absorption spectrometry and its applications.</p>	(4L)
4	<p><b>Module 4: Radioactivity</b></p> <p><b>4.1</b> Properties of radioisotopes</p> <p><b>4.2</b> Structure &amp; working of G.M counter</p> <p><b>4.3</b> Isotopic dilution analysis</p> <p><b>4.4</b> Use of isotopes in biology and Radiation hazards.</p>	(4L)
5	<p><b>Module 5: Introduction to microscopy</b></p> <p><b>5.1</b> Bright field and Dark field</p> <p><b>5.2</b> Concept of phase differences, Phase contrast microscopy, Differential</p>	(4L)

	Interference contrast (Nomarsky) microscopy	
6	<p><b>Methods for protein sequencing.</b></p> <p>N-terminal sequencing</p> <p>C-terminal sequencing.</p> <p><b>Methods for DNA sequencing</b></p> <p>Maxam- Gilbert Sequencing</p> <p>Chain termination method</p> <p>Dye terminator sequencing</p>	(4L)
7	<p><b>Centrifugation:</b> Principle, Types of centrifugation-Preparative and Analytical.</p> <p>Applications of centrifugation.</p>	(03L)

### REFERENCE BOOKS:

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, Stryer Lubert, 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 D. Russell, Publisher—Jones & Bartlett

**Course Code and Course Name:**

22-ZOUT-112 Cell Biology and Developmental Biology (4 Credit: 60 Lecture)

**Semester I**

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

**Cell Biology:**

- CO1: Label the various cell parts
- CO2: Sketch and label various types of cells and cell organelles.
- CO3: Explain the ultrastructure and functions of various cell organelles.
- CO4: Explain the concept of Protein Trafficking
- CO5: Explain the concepts of cell signalling.
- CO6: Illustrate the chemistry and organization of cytoskeleton.
- CO7: Diagrammatically represent the cell cycle phases and its regulation.

**Developmental Biology:**

- 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.
- CO7: Illustrate postembryonic development.

CO8: Compare and contrast spermatogenesis and oogenesis.

**Cell Biology:**

<b>Sr. No.</b>	<b>Name of Topic</b>	<b>Lectures allotted</b>
1	<b>Module 1:</b> Introduction to Cell Biology 1.1 Definition and Scope of Cell biology 1.2 Cell Theory 1.3 Overview of Cell Types	(02L)
2	<b>Module 2:</b> Plasma membrane: 2.1Ultrastructure- Fluid Mosaic Model, Membrane proteins: channels, carriers and pumps; 2.2Membrane transport- Active, Passive, Bulk Transport 2.3Membrane potential	(05L)
3	<b>Module 3:</b> Nucleus 3.1Ultrastructure – nuclear envelope, nuclear lamina, nuclear pore complex, nucleolus. 3.2 Functions of Nucleus	(02L)
4	<b>Module 4:</b> Endomembrane system: 4.1 Endoplasmic reticulum, Golgi complex, Lysosomes- Structure and Function 4.2 protein trafficking – secretory and endocytic pathways.	(06L)
5	<b>Module 5:</b> Mitochondria <b>5.1</b> Structure, function <b>5.2</b> Protein import	(03L)
6	<b>Module 6:</b> Cytoskeleton 6.1 Types and Organisation 6.2 Role of Cytoskeletal Proteins	(03L)
7	<b>Module 7:</b> 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	<b>Module 8:</b> 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**

<b>Sr. No.</b>	<b>Name of Topic</b>	<b>Lectures allotted</b>
1.	<b>Module 1: Basic concepts of development :</b> 1.1 Concepts of Developmental biology –Growth, Potency, Stemness, commitment, specification, induction, competence, determination and differentiation, Cryptobiosis.	(03L)
2.	<b>Module 2: Model Organisms:</b> 2.1 Invertebrate: <i>Drosophila melanogaster</i> , 2.2 Pisces: Zebra Fish- <i>Danio rerio</i> , 2.3 Amphibians: <i>Xenopus laevis</i> , 2.4 Birds: Chicken, 2.5 Mammals: Mouse.	(03L)
3	<b>Module 3: Gametogenesis:</b> 3.1 Spermatogenesis: spermatogenesis, structure of sperm, regulation of sperm motility, 3.2 Oogenesis: previtellogenesis, Vitellogenesis and post-Vitellogenesis, Structure of ovum	(04L)
4	<b>Module 4: Fertilization:</b> 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	<b>Module 5: Morphogenesis:</b> 5.1 Blastulation: Frog and Chick, Mid Blastula Transition, 5.2 Gastrulation: Frog, Chick 5.3 Neurulation: Frog, Chick 5.4 Organogenesis: vulva formation in <i>Caenorhabditis elegans</i> , eye lens induction.	(06L)
6	<b>Module 6: Pattern formation:</b> 6.1. Setting up Animal-vegetal and Dorso-Ventral axis in Amphibians, 6.2 Antero-posterior axis: <i>Drosophila</i> -role of bicoid, nanos, hunchback.	(04L)
7	<b>Module 7: Regeneration:</b> 7.1 Definition and Types- Epimorphosis and Morphallaxis 7.1 Limb regeneration in <i>Salamander</i> , 7.2 Regeneration in Hydra	(03L)
8	<b>Module 8: Growth and post embryonic development:</b> 8.1 Apoptosis 8.2 Aging and senescence.	(03L)

**REFERENCE BOOKS:****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.
3. Sadava David E. (1993) *Cell Biology – Organelle Structure and Function*. Jones & Barlett Publishers, Boston, London.
4. Hardin Jeff, Gregory Bertoni and Lewis J. Kleinsmith (2012) *World of the Cell*. 8th Edition, Pearson Education, Inc., San Francisco, U.S.A.
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.
6. Lodish H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell (1995) *Molecular Cell Biology*. Eds. 3, Scientific American & W. H. Freeman, New York.
7. De Robertis E. D. P. and De Robertis E. M. E. (1987) *Cell and Molecular Biology*. 8th Edition, Lea and Febiger, Philadelphia.
8. Nelson D. L. and Cox M. M. (2008) *Lehninger Principles of Biochemistry*. 5th Edition, W. H. Freeman & Co. NY.

**Developmental Biology:**

1. *Developmental Biology*, 9th edition (2010), S.F. Gilbert. Publisher – Sinauer, Associates Inc.
2. *Principles of Development*, 6<sup>th</sup> 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 Edition.

**Course Code and Course Name:**

22-ZOUT 113 Genetics and Skills in Scientific Communication. (4 Credit: 60 Lecture)

**Genetics :**

Sr. No.	Name of the topic	Lectures allotted
1	<b>Introduction</b> : Scope of Genetics and Practical applications of genetics in brief	(02L)
2	<b>Recapitulation of Mendelian principles; Mendel and his work</b> : Mendelian principles.	(02L)
3	<b>Classical concept of a gene</b> : Allele, pseudoalleles, multiple	(02L)

	alleles (blood groups)	
4	<b>Extensions of Mendelian principles:</b> Gene interactions and epistasis and their types.	(02L)
5	<b>Linkage and crossing over :</b> Linkage, linkage groups, types of crossing over, sex linkage, sex limited and sex influenced characters, Recombination, recombination maps in diploids for 2 point and 3 point test cross, (determination of gene order with suitable examples).	(06L)
6	<b>Quantitative genetics :</b> Polygenic inheritance, heritability and its measurements and Quantitative Traits Locus mapping.	(03L)
7	<b>Somatic cell genetics and its applications.</b>	(02L)
8	<b>Principles of Population Genetics:</b> Hardy-Weinberg law and its application for autosomal genes. Calculations of gene frequencies with suitable examples.	(05L)
9	<b>Microbial genetics :</b> Methods of genetic transfers – transformation, conjugation, transduction.	(03L)
10	<b>Extra chromosomal inheritance:</b> Inheritance of Mitochondria.	(01L)
11	<b>Human genetics:</b> Dominant and recessive disorders, physical traits.	(04L)

### Skills in Scientific Communication

Sr. No.	Name of the topic	Lectures allotted
1	<b>Language as a communication tool:</b> Relationship of language among reading, writing, listening and speaking.	(02L)
2	<b>Pragmatic competence: co-operative principles and politeness principles Introduction of Scientific Writing :</b> Introduction, Meaning, Language of a Scientific Paper	(01L)
3	<b>Organisation of English language:</b> Sentence structure, basic grammar, sequence and tenses, syntax, paragraphs, paraphrases and précis writing, synonyms and antonyms. <b>classical concept of a gene :</b> Allele, pseudoalleles, multiple alleles (blood groups)	(03L)
4	<b>Common errors in written and spoken English:</b> Tautology, double negative, double positive, superfluous words	(02L)
5	<b>Oral presentation:</b> How to prepare a presentation, power point slides, use of communication and IT, voice, speed of delivery, obstacles in effective communication	(02L)
6	<b>Outline of research project proposal writing:</b> Drafting of a research project for financial assistance from funding agency, writing of scientific paper using word processor.	(02L)
7	<b>Outline of a scientific research paper:</b> 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	(14L)

	measurements, reproducibility etc. 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	
<b>8</b>	<b>Editing and correcting:</b> Proof-reading symbols, jargons and abbreviations	(03L)
<b>9</b>	<b>Plagiarism:</b> Meaning, types, avoiding plagiarism.	(01L)

### REFERENCE BOOKS :

1. Genetics, 3Rd Edn by Strickberger, Pearson India, 2015, Paperback,
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, 9789332571624
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11. Trelease S. F. (1958) How to Write Scientific and Technical Papers. Williams and Wilkins Co. Baltimore, U.S.A.
12. Day Robert (1996) How to Write and Publish a Scientific Paper. Cambridge University Press.
13. McMillan V. (1997) Writing Papers in the Biological Sciences. Edn. 2, W. H. Freeman, New York.
14. Winkler Anthony C. and Jo Ray McCuen-Metherell (2008) Writing the Research Paper, A Handbook. 7th Edition, Wadsworth Cengage Learning, Boston, M.A., U.S.A.
15. Vijayalakshmi G. and C. Sivapragasam (2008) Research Methods – Tip & Techniques. M.J.P. Publishers, Chennai.
16. Kothari C. R. (2009) Research Methodology: Methods & Techniques. 2 nd Revised Edition, New Age International Publishers, New Delhi.

17. Levinson Stephen C. (2003) Pragmatics. Cambridge University Press, Cambridge.
18. Yule George (2012) Pragmatics (Oxford Introduction to Language Study ELT). Oxford University Press.
19. Quirk Randolph and Greenbaum Sidney (2006) A University Grammar of English. Pearson Education Ltd.
20. Editors of Merriam Webster (2006) Webster's English Usage Guide. Federal Street Press, Springfield, M. A., U.S.A.
21. Wren P. C. and H. Martin (2016) High School English Grammar and Composition. Blackie ELT Books (A Division of S. Chand & Co. Pvt. Ltd.), New Delhi, India.
22. American Psychological Association (2010) Publication Manual of the American Psychological Association. 6th Edition, Washington D.C.
23. Modern Language Association (2016) MLA Handbook. 8th Edition, The Modern Language Association of America.

**Course Code and Course Name:**

**22-ZODT-114: Freshwater Zoology (2 Credits= 30 lecturers)**

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

CO1: Enlist the diagnostic features of shrimps.

CO2: Explain the types of aquatic habitats.

CO3: Discuss the aquatic adaptations of common freshwater forms.

CO4: Explain the adaptations in freshwater Turtles and Crocodiles.

CO5: Illustrate the physicochemical properties of water.

CO6: Demonstrate the effect of pollutants on freshwater bodies

CO7: Justify the presence of zooplanktons and aquatic forms in freshwater bodies.

Sr. No.	Name of the topic	Lectures allotted
1	<p><b>Module 1: Physico-chemical properties of water</b></p> <p>1.1 Physical conditions: Water current, watercolor, turbidity, and temperature.</p> <p>1.2 Chemical conditions: pH, carbon dioxide, dissolved oxygen, hardness, alkalinity, nitrate, and phosphate.</p>	(06L)

2	<b>Module 2: Introduction to freshwater habitats.</b> 2.1 Lentic habitat: Lakes, ponds, wetlands, and ephemeral water bodies. Thermal stratification in lakes. 2.2 Lotic habitat: Major rivers in India	(02L)
3	<b>Module 3: General characters of Zooplankton with two examples</b> 3.1 Rotifera, Copepoda, Cladocera and Ostracoda	(04L)
4	<b>Module 4: Introduction to minor phyla:</b> 4.1 Gastrotricha, Bryozoa and Tardigrada (water bears).	(02L)
5	<b>Module 5: Diversity and economic importance of freshwater Crustacea and Mollusca.</b>	(03L)
6	<b>Module 6: Diagnostic features and Economic importance of freshwater fishes (two example)</b>	(02L)
7	<b>Module 7: Locomotory and respiratory adaptation in freshwater insect orders:</b> 7.1 Odonata, Coleoptera, Diptera and Hemiptera.	(03L)
8	<b>Module 8: Eutrophication: Causes and problems</b>	(03L)
9	<b>Module 9: Anthropogenic impact on freshwater:</b> 9.1 Sewage and silage, mining waste, agricultural chemicals, industrial outflows.	(04L)

**REFERENCE BOOKS:**

1. Limnology: lake and river ecosystem, Robert G. Wetzel. Academic Press, 3rd edition.
2. Treatise of Limnology. Hutchinson G. E. John Wiley Publication, New York (3 volumes).
3. Field Guide to freshwater invertebrates of North America. Thorp and Rogers. Academic press.
4. Environmental Physiology of Animals. Pat Wilmer, Graham Stone and Ian Johnston. Wiley-Blackwell; 2nd edition.
5. Current status of freshwater resources of India. Kailash Chandra, Gopi K.C., Rao D.V., Valarmathi K. and Alfred J.R.B. Zoological survey of India, 2017.
6. Freshwater Ecology: Concepts and Environmental Applications of Limnology. Academic press, 2nd edition.
7. Freshwater invertebrates of the United States. Robert Pennak. A Wiley Interscience Publication.
8. Freshwater Biology. Whipple and Ward. John Wiley & Sons Inc; 2nd edition (December 1959).
9. Freshwater Invertebrates: Ecology and General Biology. Thorp and Covich. Academic Press, 4th edition.
10. Limnological Methods. Paul and Welch. Mcgraw –Hill publication.



11. Limnological analysis. Wetzel Robert G., Springer Publication.

**Course Code and Course Name:**

**22-ZOUP-114: Zoology Lab- I (4 Credits)**

<b>Module-I Biochemistry and Biochemical Techniques</b>		
<b>1</b>	Preparation of Acid & Alkali solutions and acid-base titration <b>(Compulsory)</b>	<b>1P</b>
<b>2</b>	Principle and working of Colorimetry and spectrophotometry	<b>1P</b>
<b>3</b>	To prepare Buffers of known pH and molarity and measurement of pH of various samples, Buffering capacity	<b>1P</b>
<b>4</b>	Units and specific activity of enzymes.	<b>1P</b>
<b>5</b>	Effect of substrate concentration on enzyme activity <b>(Compulsory)</b>	<b>1P</b>
<b>6</b>	Determine the concentration of Vitamin C by titration method from various sources.	<b>1P</b>
<b>7</b>	Estimation of Sugar (Glucose) by Folin Wu method. <b>(Compulsory)</b>	<b>1P</b>
<b>8</b>	Isolate proteins by salting out / by adjusting isoelectric point. ( <b>Compulsory</b> )	<b>1P</b>
<b>9</b>	Estimation of protein by Biuret method method.( <b>Compulsory</b> )	<b>1P</b>
<b>10</b>	Principle and uses of different microscopes	<b>1P</b>
<b>11</b>	Principles of electrophoresis, separation of proteins using Gel electrophoresis.( <b>Compulsory</b> )	<b>1P</b>
<b>12</b>	To find out the capacity and nature of a given ion-exchanger. Investigate the % retention and %elution of amino acids on a given ion exchanger	<b>1P</b>
<b>13</b>	To study the effect of different solvents for a given dye using thin layer chromatography ( <b>Compulsory</b> )	<b>1P</b>
<b>14</b>	Enzyme isolation and purification by fractionation methods.	<b>2P</b>

<b>Module-II Cell Biology and Developmental Biology</b>		
1	Study of ultrastructure of cell organelles. <b>(Compulsory)</b>	<b>1P</b>
2	Study of different types of cells. <b>(Compulsory)</b>	<b>1P</b>
3	Temporary preparation of human cheek epithelial cells. <b>(Compulsory)</b>	<b>1P</b>
4	Study of different stages of mitosis in suitable material. <b>(Compulsory)</b>	<b>1P</b>
5	Study of meiosis in Grasshopper testes / Onion flower buds / <i>Aloe vera</i> with emphasis on all stages of prophase. <b>(Compulsory)</b>	<b>1P</b>
6	Limits of cleanliness (To check for microbial flora)	<b>2P</b>
7	Cell fractionation – Nuclei, mitochondria observation, nuclear count.	<b>2P</b>
8	Mounting of chick embryos and preparation of permanent mounts <b>(Compulsory)</b>	<b>1P</b>
9	Filter paper ring method for <i>in vitro</i> culturing of chick Embryo & observations.	<b>1P</b>
10	Gross anatomy and histology of chick embryo upto 72 hrs. Brain, heart, lens, ear development. <b>(Compulsory)</b>	<b>1P</b>
11	Study of embryonic and post-embryonic development using frog egg as a model system.	<b>1P</b>
12	Study of life cycle of <i>Drosophila melanogaster</i> <b>(Compulsory)</b>	<b>1P</b>
13	Study of effect of ligature in <i>Drosophila</i> / House fly larva	<b>1P</b>
14	Study of regeneration in <i>Hydra</i> / <i>Planaria</i> .	<b>1P</b>
15	Study the early developmental stages in any freshwater snail.	<b>1P</b>

**Course Code and Course Name:****22-ZOUP-115: Zoology Lab-II (2 Credits)**

<b>Module-I Genetics and English in Scientific communication</b>		
1	Study of sex linked inheritance in <i>Drosophila sp.</i>	1P
2	Study of monohybrid and Dihybrid ratio in <i>Drosophila sp.</i> ( <b>Compulsory</b> )	1P
3	Determination of gene distances and gene order for a given three-point test cross.( <b>Compulsory</b> )	1P
4	Polytene chromosomes of <i>Drosophila or Chironomous</i> -examination of puff and bands.( <b>Compulsory</b> )	1P
5	Estimation of allelic frequencies, heterozygote frequencies in human populations.( <b>Compulsory</b> )	1P
6	Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive.	2P
7	Culturing <i>E.Coli</i> on solid and liquid media	2P
8	English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, pronoun ( <b>Compulsory</b> )	1P
9	Syntax, paraphrasing and précis writing, synonyms, antonyms, abbreviations.	1P
10	Spoken English: pronunciation, diphthong, accent, clarity, speed, punctuation, simplicity and syntax	1P
11	Common errors in written and spoken presentation- Tautology, double negatives and double positives, sequence and tenses, ambiguity, spellings, jargons.	1P
12	Outline of a scientific paper; preparation of a research project.	1P
13	Writing abstracts, conclusion/ summary and acknowledgements, key words and suggest a suitable title to the given abstract/paper( <b>Compulsory</b> )	1P
14	Assigning legends to given graphs, figures and captions to given tables, Deciphering the given pictorals.	1P
15	Study of proof correction symbols; proof- reading the given text & correcting the proofs.	1P
16	How to write materials and methods , observation section of a research paper.	

1 7	Write discussion section for the given discussion-less research paper and writing Citations/ Bibliography ( <b>Compulsory</b> )	
1 8	Oral presentation: Rhythm, style, control, mock presentation of 10 minutes.	

<b>Module II: Freshwater Zoology</b>		
1	Estimation of total carbon dioxide and chloride form given water sample.	<b>1P</b>
2	Estimation of phosphates forms given water sample.	<b>1P</b>
3	Estimation of total nitrate from given water sample.	<b>1P</b>
4	Estimation of calcium and total hardness of given water sample.	<b>1P</b>
5	Estimation of total alkalinity of given water sample.	<b>1P</b>
6	Collection, preservation and identification of zooplankton from freshwater habitat. (Prepare permanent slides and Identify up to genus level using taxonomic key).	<b>2P</b>
7	A qualitative and quantitative analysis of zooplankton from a given freshwater sample using Lackey's drop count method/ Sedgwick rafter counting cell.	<b>2P</b>
8	Identification of economically important freshwater crustaceans and fishes.	<b>1P</b>
9	Study of locomotory and respiratory adaptations in aquatic insects and larvae ( <i>Ranatra</i> , <i>Notonecta</i> , <i>Gerris</i> , <i>Bellostoma</i> and <i>Dytiscus</i> ).	<b>1P</b>
1 0	Study of aquatic and semiaquatic adaptations in amphibians and reptiles.	<b>1P</b>
1 1	Estimation of primary productivity with dark and light bottle method	<b>1P</b>
1 2	To prepare and maintain a culture of paramecium, Daphnia and <i>Hydra</i>	<b>2P</b>
1 3	A Compulsory visit to local freshwater body and preparation of report on physicochemical conditions and faunal organisms.	<b>1P</b>

## M.Sc. Zoology (Semester - II)

### Course Code and Course Name:

**22- ZOUT- 121: Molecular Biology and Bioinformatics.** (4 Credits = 60 lectures)

### Semester II

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: Schematically represent the processes of central dogma.

CO8: Justify the post translational and post transcriptional modifications.

### Molecular Biology

Sr. No.	Name of the topic	Lectures allotted
1	<b>Module 1: DNA structure and topology</b> <b>1.1.</b> Types of DNA ( <b>A,B,Z</b> ) <b>1.2</b> Structure of chromatin, nucleosome <b>1.3</b> Chromatin organization and remodeling <b>1.4</b> Higher order organization - chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin	(05L)
2	<b>Module 2: Physical properties of DNA</b> <b>2.1</b> T <sub>m</sub> , hypo and hyper chromicity <b>2.2</b> Solubility, mutarotation and buoyancy.	(02L)
3	<b>Module 3: Genome organization</b> <b>3.1</b> c- value paradox and genome size <b>3.2</b> Cot curves, repetitive and non-repetitive DNA sequence and their importance <b>3.3</b> Cot ½ and Rot ½ values, kinetic and sequence complexity, satellite	(04L)

	DNA, Pseudogenes , Gene families, Gene clusters, Super-families Organelle genome	
4	<p><b>Module 4: DNA Replication</b></p> <p><b>4.1</b> DNA replication in <i>E. coli</i></p> <p><b>4.2</b> Types of <i>E. coli</i> DNA polymerases</p> <p><b>4.3</b> Origin of replication, , replication process and its regulation</p> <p><b>4.4</b> Connection of replication to cell cycle.</p> <p><b>4.5</b> Different models of replication for linear and circular DNA replication</p> <p><b>4.6</b> Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases</p> <p><b>4.7</b> ARS in yeast, Origin Recognition Complex (ORC), regulation of replication.</p>	(08L)
5	<p><b>Module 5: DNA damage and repair</b></p> <p><b>5.1</b> Different types of DNA damage</p> <p><b>5.2</b> Different DNA repair systems</p> <p><b>5.2.1</b> Nucleotide excision repair</p> <p><b>5.2.2</b> Base excision repair</p> <p><b>5.2.3</b> Mismatch repair</p> <p><b>5.2.4</b> Recombination repair</p> <p><b>5.2.5</b> Double strand break repair</p> <p><b>5.2.6</b> Transcriptional coupled repair</p> <p><b>5.2.7</b> Nick Translation and SOS Repair</p>	(05L)
6	<p><b>Module 6: Transcription</b></p> <p><b>6.1</b> Transcriptional Unit in prokaryotes and eukaryotes</p> <p><b>6.2</b> Role and significance of promoter, enhancer, intron, exon, silencer,</p> <p><b>6.3</b> Transcriptional factors, mechanism of prokaryotic gene transcription</p> <p><b>6.4</b> Type and structure of RNA polymerases</p> <p><b>6.5</b> Post transcriptional processing: Capping, polyadenylation and splicing in eukaryotes and significance, Ribonucleoproteins (SnRNPs &amp; ScRNPs)</p>	(07L)
7	<p><b>Module 7: Translation</b></p> <p><b>7.1</b> Prokaryotic translation – Genetic code, deciphering genetic code</p> <p><b>7.2</b> Structure of ribosome (prokaryotic and eukaryotic)</p>	(07L)

	<p><b>7.3</b> tRNA – structure of tRNA, modified bases of tRNA,</p> <p><b>7.4</b> Activation of tRNA Initiation – role of initiation factors, Shine Dalgarno sequences</p> <p><b>7.5</b> Elongation – Role of elongation factors</p> <p><b>7.6</b> Termination – termination codons, role of release factors</p> <p><b>7.7</b> Fidelity of translation</p> <p>7.8 Post transcriptional modifications</p>	
8	<p><b>Module 8: Gene regulation and expression in prokaryotes</b></p> <p><b>8.1</b> Lac operon</p> <p><b>8.2</b> Arabinose operon</p> <p><b>8.3</b> Trp operon.</p>	(03L)
9	<p><b>Module 9: Mobile DNA elements</b></p> <p><b>9.1</b> Transposable elements in bacteria</p> <p><b>9.2</b> IS elements, composite transposons, replicative, non-replicative transposons</p> <p><b>9.3</b> Mu transposition Controlling elements in Tn A and Tn 10 transposition</p> <p><b>9.4</b> SINES and LINES.</p> <p><b>9.5</b> Retroviruses and retrotransposon.</p>	(04L)

## Bioinformatics

Sr. No.	Name of the topic	Lectures allotted
1	<p><b>Module 1: Introduction</b></p> <p><b>1.1</b> Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, ExPASy, PubMed, OMIA)</p> <p><b>1.2</b> Applications of Bioinformatics</p>	(02L)
2	<p><b>Module 2 :Databases – Tools and their uses</b></p> <p><b>2.1</b> Biological databases, Primary sequence databases</p> <p><b>2.2</b> Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ )</p> <p><b>2.3</b> Protein sequence data bases (UniProtKB, PIR, PDB)</p> <p><b>2.4</b> Secondary sequence databases</p>	(04L)

	<b>2.5</b> Derived databases - PROSITE, BLOCKS, Pfam/ Prodom <b>2.6</b> Structure databases and bibliographic databases	
3	<b>Module 3: Sequence alignment methods</b> <b>3.1</b> BLAST, FASTA <b>3.2</b> Significance of sequence alignment <b>3.3</b> Pairwise sequence alignment (Needleman & Wunsch, Smith & Waterman methods) <b>3.4</b> Multiple sequence alignment (PRAS, CLUSTALW)	(04L)
4	<b>Module 4: Predictive applications using DNA and protein sequences</b> <b>4.1</b> Evolutionary studies: Concept of phylogenetic trees <b>4.2</b> Parsimony and Bayesian approaches <b>4.3</b> Protein Chips and Functional Proteomics: Different types of protein chip, detecting and quantifying, applications of Proteomics <b>4.4</b> Role of virus based vectors <b>4.5</b> Omics: Pharmacogenomics: Discovering a drug: Target identification  Metabolomics: Concept and applications	(05L)

#### REFERENCE BOOKS:

1. Genes IX, 9th edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers, 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 and Course Name: 22-ZOUT-122 Endocrinology and Comparative Animal Physiology (4C)**

**Endocrinology:**

Sr. No.	Name of the topic	Lectures allotted
1	<b>Module 1: Introduction of Endocrinology</b> 1.1 Introduction, Hormones- structure and role as chemical messenger 1.2 Types of hormones-protein and non-protein	(02L)
2	<b>Module 2: Hormone receptors :</b> 2.1 Receptors on the plasma membrane, cytoplasm & nucleus	(02L)
3	<b>Module 3: Mechanism of hormone action:</b> 3.1 Mechanism of hormone action- signal transduction cascade.	(02L)
4	<b>Module 4: Endocrine system</b> 4.1 Hypothalamic hypophysiotropins	(02L)
5	<b>Module 5: Adenohypophysial hormones</b> 5.1 ACTH, PRL, STH and TSH	(04L)
6	<b>Module 6: Control of chromatophores</b> 6.1 Pituitary, pineal	(02L)
7	<b>Module 7: Hormonal regulation of carbohydrates, protein &amp; lipid metabolism</b> 7.1 Pancreatic hormones- glucocorticoids	(03L)
8	<b>Module 8: Osmoregulatory hormones</b> 8.1 ADH, mineralocorticoids, renin-angiotensin	(02L)
9	<b>Module 9: Regulation of Gastrointestinal tract</b> 9.1 Gastrointestinal hormones.	(02L)
10	<b>Module 10: Endocrine control</b> 10.1 Control of calcium and phosphate metabolism	(02L)
11	<b>Module 11:Endocrine mechanism in crustacean: 11.1 X &amp; Y</b> organs 11.2 Regulation of metabolism 11.3 Salt and water balance, reproduction 11.4 Colour change, moulting	(03L)

<b>12</b>	<b>Module 12: Chronobiology</b> 12.1 Introduction, significance, Clocks, Rhythm and Calendar 12.2 The biological timing system: Concepts and methods, Types: Ultradian, circadian and circannual rhythms	(03L)
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### Comparative Animal Physiology:

Sr. No.	Name of the topic	Lectures allotted
<b>1</b>	<b>Module 1: Digestion</b> 1.1 Digestive system: Physiology of digestion and absorption.	(03L)
<b>2</b>	<b>Module 2: Respiration</b> 2.1 Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. 2.2 Blood pigment, role in Oxygen transport. 2.3 O <sub>2</sub> dissociation curves physiological and ecological significance, CO <sub>2</sub> .  <b>Respiratory system :</b> 2.4 Comparison of respiration in different species, anatomical considerations 2.5 Transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	(04L)
<b>3</b>	<b>Module 3: Muscle contraction</b> 3.1 Structure (light & electron microscopic) of the skeletal muscle 3.2 Proteins of the myofilaments, nature of actin-myosin interaction 3.3 Sarcoplasmic reticulum and role of Ca <sup>++</sup> in contraction	(04L)
<b>4</b>	<b>Module 4: Osmotic regulation</b> 4.1 Concepts of osmole , osmolarity and tonicity, ionic regulation, 4.2 Hyper- and hypo-osmotic regulators, ureosmotic animals.	(04L)
<b>5</b>	<b>Module 5: Excretion, Comparative physiology of excretion</b> 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)
<b>6</b>	<b>Module 6: Thermoregulation</b> 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)
<b>7</b>	<b>Module 7: Chemical Communication</b> 7.1 Neurosecretion, neurohemal & endocrine organs.	(03L)
<b>8</b>	<b>Module 8: Sense organ</b> 8.1 Classification & functions (details of photoreception as a model). Reflexes, Principles of neural integration.	(04L)

**REFERENCE BOOKS:**

1. Bentley, P.J. (1998). Comparative vertebrate endocrinology, edn.3, Cambridge University Press, London.
2. Bollander, F. (1994). Molecular endocrinology, edn.2, Acad. Press, San Diego.
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.
5. Hoar, W.S. and Hickman, C.P., Jr. (1983). A laboratory companion for general and comparative physiology. Edn.3, Prentice-Hall, Englewood Cliffs, N.J., USA.
6. Kobayashi, H. Malsumolo, A. and Ishii, S. (Eds.) (1992). Atlas of endocrine organs: vertebrates and invertebrates. Springer Verlag, Berlin.
7. Zarrow, M.X., Yachim, J.M. and McCarthy, J.L. (1964). Experimental endocrinology: a sourcebook of basic techniques. Academic Press, New York
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 and Course Name:**

**22- ZOUT- 123 Environmental Biology and Parasitology**

(4 Credits= 60 lecturers)

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

**Environmental Biology:**

CO1: List the endangered, endemic and extinct animal species of India.

CO2: Identify various types of natural resources, human impact on these resources, and common resource management practices.

CO3: Explain the structure and impact of biogeochemical cycles, ecosystems and energy transformation across trophic levels.

CO4: Describe concepts in population ecology and their significance.

CO5: Discuss environmental hazards and risks and the socio-economic implications.

CO6: Illustrate the impact of climate and anthropogenic factors on biodiversity with reference to India.

CO7: Illustrate the wildlife management practices and their significance.

CO8: Analyze the impact of lifestyle on the environment and animal life.

### **Parasitology:**

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: Illustrate the process of parasitic infections to human.

CO7: Justify the importance of control strategies against parasitic infections.

CO8: Justify the significance of vectors and disease transmission.

### **Environmental Biology:**

Sr. No.	Name of the topic	Lectures allotted
1.	<b>Module 1: Environmental Biology</b> 1.1 Introduction- Definition, basic concepts and scope	(02L)
2	<b>Module 2: The Ecosystem</b> 2.1 Definition, abiotic and biotic components and their interrelationship 2.2 Energy flow in ecosystem, Nutritional Flux. 2.3 Food chain in ecosystem and food web 2.4 Ecotone and edge effects, ecosystem stability	(04L)
3	<b>Module 3: Population and Community Ecology</b> 3.1 Characteristic of population: Density, Natality, Mortality, Fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. 3.2 Population regulation – density-dependent and independent factors. 3.3 Community characteristics: species richness, dominance, diversity, Abundance 3.4 Biodiversity Indices: Simpson Diversity Index, Shannon Diversity Index.	(04L)
4	<b>Module 4: Biomes and Habitat Diversity:</b>	(03L)

	4.1 Classification of biomes, major biotic elements of each biome and their characteristics. 4.2 Human impact on the natural environment.	
5	<b>Module 5: Biological diversity of India:</b> 5.1 Definition and nature, India's biogeographical history, physiography, climate and its impact on biodiversity. 5.2 Indian forest and vegetation types and diversity of flora and fauna.	(04L)
6	<b>Module 6: Wildlife management and conservation.</b> 6.1 Definition, causes of wildlife depletion 6.2 Importance of wildlife management in India 6.3 Protected Areas Network in India: Goals of management, Strategies for planning. 6.4 Important projects for the conservation of wildlife in India 6.5 Role of local communities in wildlife management.	(06L)
7	<b>Module 7: Endangered, Endemic and Extinct Species of India:</b> 7.1 Species categories of IUCN, threatened species of animals and the reasons, 7.2 Red data book 7.3 CITES 7.4 Biodiversity hotspots of India.	(03L)
8	<b>Module 8: Environmental Microbiology:</b> 8.1 Microbes - classification and their applications in the environmental sciences. 8.2 Microorganisms and their association with man, animals and plants. 8.3 Microbes as anti-microbial agents.	(03L)
9	<b>Module 9:</b> Introduction to human animal conflict.	(01L)
<b>Parasitology</b>		
Sr. No.	Name of the topic	Lectures allotted
1	<b>Module 1: Host-Parasite systems</b> 1.1 Preadaptation to infectiousness 1.2 Myiasis: Classification according to tissue, vectors specific, sub specific, accidental 1.3 Symptoms, diagnostic, control method prevention, treatment.; Transmission: Types, categories: A. Conspecific: Contact, Transplacental, Transovarian B. Heterospecific: Mechanical (Indirect & Direct), Biological Paratenic, Hyper parasitic, Parasitoidal. 1.4 Manipulation of Host behaviour, Parasitism & Altruism 1.5 Parasites & social behavior of hosts 1.6 Parasitism & life history, parasitic effects benefiting the host.	(07L)
2	<b>Module 2: Type study</b> 2.1 Classification, geographical distribution, morphology, life-cycle 2.2 Transmission, pathogenicity, treatment and prophylaxis of: 2.2.1 Protozoa: <i>Trypanosoma</i> Sps, <i>Leishmania</i> Sps. 2.2.2 Platyhelminthes: <i>Schistosoma</i> Sps., <i>Echinococcus</i> Sps. 2.2.3 Nematoda: <i>Ancylostoma</i> Sps., <i>Dracunculus</i> Sps.	(08L)

3	<p><b>Module 3: Mycology</b></p> <p>3.1 General Mycology : Fungus – Classification, Fungal Structure &amp; Morphology</p> <p>3.2 Reproduction in fungi</p> <p>3.3 Normal fungal flora of human beings.</p> <p>3.4 Immunity to Fungal Infections</p> <p>3.5 Diagnostic Mycology - Epidemiology, Pathogenesis, Laboratory Diagnosis of Fungal Infections.</p> <p>3.6 Specimen collection, preservation, Transportation &amp; Identification of Mycological Agent.</p>	(07L)
4	<p><b>Module 4: Serology &amp; immunodiagnostic methods</b></p> <p>4.1 Serology &amp; antibody synthesis, preparation &amp; demonstration of specific antigens of <i>Entamoeba</i>, <i>Plasmodium</i>, <i>Trypanosoma</i> &amp; <i>Leishmania</i></p> <p>4.2 Immunodiagnostic assays, Immunodiffusion, haemagglutination test, Radioimmuno assay, ELISA, complement fixation test.</p>	(06L)
5	<p><b>Module 5: Prophylaxis &amp; control</b></p> <p>5.1 Biological, Genetic, Chemical, Physical &amp; Other methods.</p>	(02L)

**REFERENCE BOOKS:**

1. Comparative protozoology, Ecology, Physiology, Life history, Anderson, O.R. , Springer verlag, Berlin.
2. General Parasitology, Cheng T. C., Academic Press.
3. Modern Parasitology, Cox F.E.G.,Eds. Parasitology in focus, facts & trends, Melhornh.,Eds., SprigerVerlag, Beriin.
4. Medical Parasitology, Piakarsky G. L., Springer Verlag, Berlin.
5. Modern Parasitology, Cellular immunological & immunological aspects,Wyler D. J., Eds.,
- 6.. Fundamentals of Ecology: E. P. Odum
7. Modern concepts in Ecology: H: D. Kumar
8. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. andBurns, R.G. John Wiley and Sons.
9. Elements of Microbiology: Pelczar, M.J. and Chan ECS, McGraw Hill.
10. General Microbiology: Stainer, R.Y, Adelberg, EA and Ingraham, J.L. . Macmillan Press.
11. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. . Academic Press.
12. Microbiological Methodsfor Environmental Scientists and Enginners
12. Gaudy, A.F. and Guady, E.T. McGraw Hill.

**Course Code and Course Name:****22-ZODT-124: Ichthyology (2 Credits= 30****lecturers)Semester II**

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

CO1: Understand the common fishes of India.

CO2: Explain 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 topic	Lectures alloted
1	<p><b>Module 1:</b></p> <p>1.1 Introduction, general characteristics, evolutionary succession and fossil history of fishes.</p> <p>1.2 The early evolution of fishes: Chondrichthian fishes - Sharks, Skates and Rays.</p>	(03L)
2	<p><b>Module 2:</b></p> <p>2.1 Eschmeyer's classification of fishes and diagnostic characters up to orders( one major order from each class).</p>	(04L)
3	<p><b>Module 3:</b></p> <p>3.1 External morphology, body form, appendages, pigmentation, skin and scales.</p>	(01L)
4	<p><b>Module 4:</b></p> <p>4.1 Food and feeding habits</p> <p>4.2 Digestive system and its anatomical modifications.</p>	(02L)
5	<p><b>Module 5:</b></p> <p>5.1 Respiratory mechanism: Respiratory gills and lungs.</p> <p>5.2 Accessory respiratory organs:</p> <p>5.3 Origin of air breathing organs; skin, buccopharynx opercular cavity and air bladder.</p>	(02L)
6	<p><b>Module 6:</b></p> <p>6.1 Circulatory system: Heart and accessory pumps.</p>	(02L)



7	<p><b>Module 7:</b></p> <p>7.1 Excretion and Osmoregulation: Glomerular and aglomerular kidneys;</p> <p>7.2 Nitrogen (ammonia, urea, TMAO) excretions. Water and salt balance in steno- and euryhaline fishes.</p> <p>7.3 Role of skin and gills.</p>	(03L)
8	<p><b>Module 8:</b></p> <p>8.1 Reproduction: Structure of gonads, gametogenic cycles; spawning.</p>	(02L)
9	<p><b>Module 9:</b></p> <p>9.1 Nervous system and Sense organs: 9.2 Organization of the central and peripheral nervous systems.</p> <p>9.3 Olfactory, taste buds, touch receptors, photoreceptors, lateral line and internal ear</p>	(03L)
10	<p><b>Module 10:</b></p> <p>10.1 Endocrine system: Pituitary gland, urophysis, adrenal gland, gonads, and thyroid gland.</p>	(02L)
11	<p><b>Module 11:</b></p> <p>11.1 Fish pathology: Signs of sickness and effects on fish; 11.2 Pathological procedure for diagnosis of fish diseases,</p> <p>11.3 Symptoms and control measures of viral, bacterial, fungal, protozoan, worm and crustacean diseases.</p>	(02L)
12	<p><b>Module 12:</b></p> <p>12.1 Ornamental Fish production and</p>	(04L)

	<p>management: World trade of ornamental fishes.</p> <p>12.2 Different varieties of exotic and indigenous ornamental fishes.</p> <p>12.3 Principles of a balanced aquarium. 12.4 Fabrication, setting up and maintenance of freshwater aquarium. 12.5 Water quality management. Water filtration system – biological, mechanical and chemical.</p> <p>12.6 Types of filters. Aquarium plants and their propagation methods. Lighting and aeration.</p> <p>12.7 Aquarium accessories and decoratives. Aquarium fish feeds. Dry, wet and live feeds.</p> <p>12.8 Breeding and rearing of ornamental fishes.</p> <p>12.9 Common diseases and their control. 12.10 Conditioning, packing, transport and quarantine methods.</p> <p>12.11 Trade regulations and wild life act in relation to ornamental fishes.</p>	
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**Course Code and Course Name:**

22-ZOUP-124 Zoology Lab-

I (4Credits)

**Semester II.**

Note: A total of 30 practicals are to be conducted. 10 practicals from each module are to be conducted. 1 practical is of 4 clock hour duration.

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

CO1: Identify the various parasites and parasitic stages of common parasites, nitrogenous wasteproducts of animals, feshwater planktons and slides of endocrine glands.

CO2: Explain the principle and significance of gonadectomy, thyrodectomyandpancreactomy.

CO3: Demonstrate the role of eye stalk and insulin in sugar level in crab.CO4:

Demonstrate the retro cerebral complex in cockroach.

CO5: Demonstrate the RBCs of common vertebrates and effect of various osmolarities.

CO6: Demonstrate the effect of body size, oxygen consumption and Insulin on aquaticanimal.

CO7: Determine the bleeding and clotting time, heartbeat of crab, species richness inselected area, physico-chemical properties of soil and water.

CO8:Perform Sterilization of lab equipment, prepare microbial culture, Isolate Bacterial,liver DNA and RNA from given sample, quantify and resolve them using electrophoretic procedures, analyse protein sample by PAGE and SDS PAGE andconstruct phylogenetic tree using tools inbioinformatics

<b>Module-I Molecular Biology and Bioinformatics</b>		
<b>1</b>	Lab Safety Techniques and sterilization.	<b>1P</b>
<b>2</b>	Isolation of bacterial DNA and estimation by UV spectrophotometry <b>(Compulsory)</b>	<b>2P</b>
<b>3</b>	Isolation of Liver DNA and quantification, Agarose gel electrophoresis of isolated DNA. <b>(Compulsory)</b>	<b>2P</b>
<b>4</b>	Isolation of RNA and agarose gel electrophoresis.	<b>1P</b>
<b>5</b>	Concept of biological database, gene and protein search by BLASTA and FASTA <b>(Compulsory)</b>	<b>1P</b>
<b>6</b>	To analyse protein on native PAGE and SDS-polyacrylamide gel electrophoresis. <b>( Compulsory)</b>	<b>2P</b>
<b>7</b>	Construction of phylogenetics tree for DNA and protein <b>(Compulsory)</b>	<b>1P</b>
<b>8</b>	Demonstration of DNA amplification by PCR	<b>1P</b>

<b>Module-II Endocrinology and Comparative Animal Physiology</b>		
<b>1</b>	Histology of invertebrate and vertebrate neurosecretory and endocrine structures. <b>(Compulsory)</b>	<b>1P</b>
<b>2</b>	Blood sugar regulation in the crab- role of eye stalk. <b>(Compulsory)</b>	<b>1P</b>
<b>3</b>	Study of retrocerebral complex of the cockroach.	<b>1P</b>
<b>4</b>	Introduction of alloxan diabetes in the mouse/ rat / human. <b>(Compulsory)</b>	<b>1P</b>

5	Gonadectomy in the mouse/ rat.	2 P
6	Pancreatectomy in the mouse/ rat.	1 P
7	Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human. <b>(Compulsory)</b>	1 P
8	Thyroidectomy in the rat.	1 P
9	Study of nitrogenous waste products of animals from different habitats. <b>(Compulsory)</b>	1 P

1 0	Study of RBCs in different vertebrates and in different physiological conditions.	1P
1 1	Study of relation of Body size and oxygen consumption in aquatic animals (crab/fish). <b>(Compulsory)</b>	1P
1 2	Estimation of sugar in rat/crab/human blood. <b>(Compulsory)</b>	1P
1 3	Determination of bleeding time & clotting time of human blood. <b>(Compulsory)</b>	1P

<b>1</b> <b>4</b>	Determination of the heart beat in the crab-effect of temperature & ions.	<b>1P</b>
<b>1</b> <b>5</b>	Effect of eye stalk ablation on glucose in the haemolymph of the crab.	<b>1P</b>

**Course Code and Course Name:**

**22-ZOUP-125 Zoology Lab- II (2Credits)**

**Semester II.**

<b>Module-I Parasitology and Environmental Biology</b>		
1	Study of life cycle, role as vector & control measures of: Ticks ( <i>Argas</i> , <i>Boophilus</i> ) Mosquito – any two from- <i>Anopheles</i> / <i>Aedes</i> / <i>Culex</i> Any two flies: <i>Tabanus</i> / <i>Phlebotomus</i> / <i>Sarcophaga</i> . Cyclops. ( <b>Compulsory</b> ) (Specimen, Slides or charts may be used.)	1P
2	Ectoparasites & Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta.	2P
3	Study of life cycle of parasitic protozoa: <i>Trypanosoma</i> , <i>Leishmania</i> . ( <b>Compulsory</b> )	1P
4	Study of life cycle of helminth parasites: <i>Schistosoma</i> , <i>Echinococcus</i> , <i>Ancylostoma</i> , <i>Dracunculus</i> ( <b>Compulsory</b> )	2P
5	Study of Parasites from digestive tract of Cockroach/gut / parasites of hen. ( <b>Compulsory</b> )	1P
6	A visit to aquatic ecosystem and methods for water and plankton collection. ( <b>Compulsory</b> )	2P
7	Plankton identification and quantification from river / lake water samples. ( <b>Compulsory</b> )	2P
8	Vegetation studies by line, quadrates and belt transect methods and their analysis.	2P
9	Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples. ( <b>Compulsory</b> )	2P
10	Water analysis for physico-chemical characteristics. ( <b>Compulsory</b> )	1P
11	Physico-chemical analysis of soil. ( <b>Compulsory</b> )	1P

<b>Module II: Ichthyology</b>
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	<b>Module II: Ichthyology</b>	
<b>1</b>	Study of fish evolution with the help of charts/models/Pictures.	<b>1P</b>
<b>2</b>	General external characters, fins and scales (permanent slides & temporary preparations and submission during examination).	<b>1P</b>
<b>3</b>	Classification of fishes (one example from each order); use of diagnostic keys.	<b>2P</b>
<b>4</b>	Length-weight relationship, condition factor, gonado-somatic index of any one fish species.	<b>1P</b>
<b>5</b>	Adaptations of fishes (adhesive organs, accessory respiratory organs, stomachless fishes, spiral valve, electric organs and sense organs.)	<b>1P</b>
<b>6</b>	Study of Weberian ossicles in Heteropneustes/ Labeo.	<b>2P</b>
<b>7</b>	Anatomical observations, demonstration and detailed explanation of fish in general, Digestive, urino-genital system, Endocrine glands of carp/ catfish/ Tilapia.	<b>2P</b>
<b>8</b>	Identification of fish developmental stages: egg, spawn, fry fingerling and adult.	<b>1P</b>
<b>9</b>	Cranial nerves (V, VII, IX & X) and eye ball musculature and innervations in Scoliodon/ carp/ catfish.	<b>1P</b>
<b>10</b>	Histology of digestive, respiratory, excretory, reproductive and endocrine organs.	<b>1P</b>
<b>11</b>	Study of common diseases in fish their diagnosis and control strategies.	<b>1P</b>
<b>12</b>	Setting up of an aquarium and its management and study of breeding behaviour of gourami, Siamese fighting and swordtail.	<b>2P</b>
<b>13</b>	Visit to fish farm/ fish breeding centre/fish market and preparation of detail visit report.	<b>1P</b>

Chairman, BOS

Principal





