



Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Zoology

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Zoology) Part-I

(for Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

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 of SavitribaiPhule Pune University 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 areas like Genetics, Animal Physiology and 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 gives 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 of SavitribaiPhule Pune University Pune. The curriculum designed

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 newly designed 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.

M.Sc. Zoology - Course structure & Distribution of Credits

M.Sc. Zoology, Part –I, Semester-I

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 111 Biochemistry and Biochemical Techniques	-			-	4
2	ZOUT 112 Cell Biology and Developmental Biology	-			-	4
3	ZOUT 113 Genetics and English in Scientific Communication.	-			-	4
4	-	ZODT 114 Theory.	Biostatistics/ Freshwater Zoology	2	-	4
		ZODP 114 Practical	Zoology Practical Paper-1	2		
5	-	-			ZOUP 115 Basic Zoology Lab-I	4
Total Credit of Semester 1						20

M.Sc. Zoology, Part-I, Semester-II

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 121 Molecular Biology and Bioinformatics	-			-	4
2	ZOUT 122 Endocrinology and Parasitology	-			-	4
3	ZOUT 123 Comparative Animal Physiology and Environmental Biology.	-			-	4
4	-	ZODT 124 Theory. ----- ZODP 124 Practical	Metabolic pathways / Ichthyology Zoology Practical Paper-2	2 2	-	4
5	-	-			ZOUP 125 Basic Zoology Lab-II	4
Total Credit of Semester 2						20

M.Sc. Zoology, Part-II, Semester - III

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 231 Special Paper (any one) Animal Physiology-I/ Entomology-I/ Genetics-I	-			-	4
2	ZOUT 232 Fundamentals of Systematics and Economic Zoology	-			-	4
3	ZOUT 233 Research Methodology and Insect Physiology and Biochemistry	-			-	4
4	-	ZODT 234 Theory ----- ZODP 234 Practical	Immunology/ Genetic Toxicology/ Zoology Practical Paper-3	2 2	-	4
5	-	-			ZOUP 235 Special Lab I	4

M.Sc. Zoology, Part II, Semester – IV

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 241 Special Paper-Any One- Animal Physiology-II/ Entomology-II/ Genetics-II	-			-	4
2	ZOUT 242 Mammalian Reproductive Physiology and Aquaculture				-	4
3	-	ZODT 243 Theory. ----- ZODP 243 Practical	Histology and Histochemistry/ Pest Control Zoology Practical Paper-4	2 2	-	4
4	-	ZODT 244 Theory. ----- ZODP 244 Practical	Pollution Biology. / Apiculture Zoology Practical Paper-5	2 2	-	4
5	-	-			ZOUP 245 (Project)	4
Total Credit of Semester 4						20

Equivalence of Previous Syllabus:

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY101T: Biochemistry-I	ZOUT 111 Biochemistry and Biochemical Techniques
ZY102T: Cell Biology	ZOUT 112 Cell Biology and Developmental Biology
ZY103T: Genetics	ZOUT 113- Genetics and English in Scientific Communication.
ZY104T: Biostatistics	ZODT 114 Biostatistics
ZY105T: Skills in scientific communication and Writing	ZOUT 113 Genetics and English in Scientific Communication.
ZY106T: Freshwater Zoology	ZODT 114 Freshwater Zoology
ZY101P: Practicals in Biochemistry	ZOUP 115 Basic Zoology Lab-I
ZY102P: Practicals in Cell Biology	
ZY103P: Practicals in Genetics	
ZY105P: Practicals in Skills in scientific communication and writing	
ZY106P: Practicals in Fresh water zoology	
ZY104P: Practicals in Biostatistics	ZODP 114 Zoology Practical-1

Semester-II

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY201T: Biochemistry-II	ZODT 124 Metabolic pathways
ZY202T: Molecular Biology	ZOUT 121 Molecular Biology and Bioinformatics
ZY203T: Developmental Biology	ZOUT 112 Cell Biology and Developmental Biology
ZY204T: Endocrinology	ZOUT 122 Endocrinology and Parasitology

ZY205T: Comparative Animal Physiology	ZOUT 123 Comparative Animal Physiology & Environmental Biology
ZY206T: Biochemical Techniques/Ichthyology	ZOUT 111 Biochemistry & Biochemical Techniques ZODT 124 Ichthyology
ZY201P: Practicals in Biochemistry-II	ZOUP 125 Basic Zoology Lab-II
ZY202P: Practicals in Molecular Biology	
ZY203P: Practicals in Developmental Biology	
ZY204P: Practicals in Endocrinology	
ZY205P: Practicals in Comparative Animal Physiology	
ZY206P: Practicals in Biochemical Techniques/ Ichthyology	ZODP 124 Zoology Practical-2

Detailed Syllabus with Recommended Books:

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.

PO6. The Postgraduate and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex life activities with the scientific community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of Zoology and management principles and apply these to one's own work, as a member and leader in a team.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Following is the syllabus of each course along with the course outcomes:

Course Code and Course Name:

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.

CO9: Compare the various separation techniques.

Sr. No.	Name of the topic	Lectures allotted
Biochemistry:		
1.	Basics of chemistry- Structure of atoms, molecules and chemical bonds, Normality, molarity, molality	(02L)
2.	Chemistry of Water : Structure of water and physicochemical properties of water, water as universal solvent, pH and Buffers, Biological Buffer System	(04L)
3.	Carbohydrates: Classification, basic Structures and functions, Biological Significance.	(03L)
4.	Lipids: Classification, structure and function and biological significance.	(03L)
5.	Vitamins: Classification- water-soluble and fat-soluble vitamins, Biological significance.	(02L)
6.	Amino acids: Classification, properties (Physical properties- Optical Isomerization, Absorption in UV light, Ionization; Chemical properties- Reactions with carboxyl group and amino group)	(02L)
7.	Proteins: a. Peptide bond formation, Ramachandran plot. b. Protein structure:-Primary structure, Secondary structure, Tertiary structure and Quaternary structures with examples, Biological significance of proteins.	(05L)
8.	Enzymes: a. Classification, nomenclature and properties b. Enzyme kinetics -one substrate reaction (Michaelis-Menten Equation) c. Factors affecting enzyme activity d. Enzyme inhibition e. Allosteric Enzymes. f. Isozymes (LDH) and coenzymes g. Clinical and industrial significance- Any 3	(09L)
Biochemical Techniques:		
1.	Chromatography: Principle, working and applications of: Adsorption chromatography Partition chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Affinity chromatography, Gas chromatography, High Performance Liquid Chromatography.	(8L)

2. **Electrophoresis:** Moving boundary electrophoresis, zone electrophoresis, (5L)
different supports used for electrophoresis, electrophoresis of proteins,
electrophoresis of Nucleic acids, isoelectric focussing.
3. **Absorption spectroscopy:** Concepts of light & electromagnetic spectrum, (5L)
Ultraviolet and Visible spectrophotometry, atomic absorption spectrometry and
applications.
4. **Radioactivity:** Properties of radioisotopes, commonly used isotopes, structure & (3L)
working of G.M, counter, isotopic dilution analysis, use of isotopes in biology,
radiation hazards.
6. **Manometry:** Respiratory quotient determination, Principle of Warburg's (2L)
apparatus, working and applications.
7. **Methods for protein sequencing.** (4L)
N-terminal sequencing
C-terminal sequencing.
Methods for DNA sequencing.
Maxam- Gilbert Sequencing
Chain termination method
Dye terminator sequencing
8. **Centrifugation:** Principle, Types of centrifugation- Preparative and (3L)
Analytical.applications of centrifugation.

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, 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 D. Russell, Publisher-Jones & Bartlett

Course Code and Course Name:

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 carbon as backbone of biomolecules.

CO4: Explain the ultrastructure and functions of various cell organelles.

CO5: Explain the concepts of cell signalling.

CO6: Illustrate the chemistry and organization of cytoskeleton.

CO7: Illustrate the types, development and causes of tumor.

CO8: 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 and cleavage pattern.

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.

Sr. No.	Name of the topic	Lectures allotted
1.	Cell theory, general organisation of cell and characteristics of living systems.	(02L)
2.	Overview of chemical nature of the cell and importance of carbon in biologically important molecules.	(02L)
3.	Plasma membrane: Ultrastructure, membrane proteins; membrane transport – channels, carriers and pumps; membrane potential and synaptic transmission.	(04L)
4.	Endomembrane system: (Endoplasmic reticulum, Golgi complex, Lysosomes); protein trafficking – secretory and endocytic pathways.	(04L)
5.	Mitochondria: Structure, genetic system, functions; protein import	(03L)
6.	Nucleus: Ultrastructure – nuclear envelope, nuclear lamina, nuclear pore complex, nucleolus.	(03L)
7.	Cell Cycle: Phases, check points, mechanism of regulation; regulators of cell cycle progression – MPF, cyclins and cyclin dependent kinases (CDKs).	(03L)
8.	Cytoskeleton: Types, chemistry, organisation, associated proteins and their role.	(03L)
9.	Cancer: Types, development, causes; characteristics of cancer cell, tumour viruses, oncogene and tumour suppresser gene.	(03L)
10.	Cell signalling: Signalling molecules and their receptors, cell surface receptors,significance of cell signalling.	(03L)
	Developmental Biology:	
1.	Introduction to developmental biology: Early theories of Developmental biology Concepts of Developmental biology – Growth, cell division, cell differentiation, cell communication, signalling, patterning, induction and competence.	(3L)
2.	Model Organisms: Invertebrate: <i>Drosophila melanogaster</i> , Pisces: Zebra Fish- <i>Danio rerio</i> , Amphibians: <i>Xenopus laevis</i> , Birds: Chicken, Mammals: Mouse.	(3L)
3.	Gametogenesis: Spermatogenesis: spermatogenesis, structure of sperm, regulation of sperm motility, Oogenesis: structure of ovum, previtellogenesis, vitellogenesis and post-vitellogenesis	(2L)
4.	Fertilization: Concept of fertilization, types of fertilization, Species specific sperm attraction, recognition of egg & sperm, acrosome reaction, signal transduction, molecular strategy to avoid polyspermy in fertilization	(4L)

5. **Types of eggs:** Based on amount of distribution of yolk, Cleavage: types and significance. (2L)
6. **Morphogenesis:** Blastulation: Amphioxus, Frog, Chick, Mid Blastula Transition, (5L)
Comparative study of Gastrulation in Amphioxus, Frog, Chick
Neurulation: Frog, Chick
Organogenesis: Development of the vertebrate eye –formation of eye field, cell differentiation
7. **Pattern formation: Setting up the body axis** (4L)
1. Animal vegetal axis: Amphibians,
2. Dorsal ventral axis: Amphibians
3. Antero-posterior axis: *Drosophila*-role of bicoidnanos hunchback.
8. **Organizers:** (2L)
Spemann and Mangold: Primary embryonic induction, Functions of organizer, Molecular mechanisms of Amphibian axis formation
9. **Regeneration:** (3L)
Limb regeneration: Salamander, Regeneration in Hydra
10. Apoptosis, aging and senescence. (2L)

REFERENCE BOOKS:

1. Karp Gerald (2010) *Cell Biology*. 6th Edition, John Willey & Sons (Asia) Pte. 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*. 5th 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. Loewy A. G., P. Siekevitz, J. R. Menninger and J. A. N. Gallant (1991) *Cell Structure & Function*. Saunders College Publishing, U.S.A.
 9. Nelson D. L. and Cox M. M. (2008) *Lehninger Principles of Biochemistry*. 5th Edition, W. H. Freeman & Co. NY.
 10. *Developmental Biology*, 9th edition (2010), S.F. Gilbert. Publisher – Sinauer, Associates Inc.
 11. *Principles of Development*, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford, University Press.
 12. *An Introduction to Embryology*, 5th edition (2004), B. I. Balinsky. Publisher – ThomasAsia Pvt. Ltd.
 13. *Developmental Biology*, (2001), R. M. Twyman, Publisher - Bios Scientific, Publishers LTD.
 14. *Analysis of Biological Development*, 2000, Klaus Kalthoff, McGraw-Hill Science/Engineering/Math; 2nd Ed edition.

Course Code and Course Name:

ZOUT 113 Genetics and English in Scientific Communication. (4 Credit: 60 Lecture)

Semester I

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

Genetics:

CO1: Define the basic terminologies in genetics.

CO2: Identify genetic disorders based on Karyotypes and traits.

CO3: Explain the concept of Mendelian genetics, gene, gene regulation and multiple alleles.

CO4: Discuss Linkage and crossing with their types and significance.

CO5: Explain the principles of Population genetics.

CO6: Illustrate the modified Mendelian laws of inheritance.

CO7: Justify the inheritance of qualitative and quantitative traits.

CO8: Solve the problems based on gene frequency.

English in Scientific Communication:

CO1: Write the outline of a scientific paper.

CO2: Write the title, abstract, discussion and citations of a given scientific article.

CO3: Prepare a scientific presentation using PowerPoint.

CO4: Explain language as a tool for effective scientific communication.

CO5: Use the formal elements of specific types of scientific writing.

CO6: Critically analyze data from research; incorporate it into assigned writing clearly, concisely, and logically; and attribute the source with proper citation.

CO7: Practice the unique qualities of professional rhetoric and writing style, such as sentence conciseness, clarity, accuracy, honesty, avoiding wordiness or ambiguity, using direct order organization, readability, coherence and transitional devices.

CO8: Justify the importance of plagiarism check and Proof-read given article.

Sr. No.	Name of the topic	Lectures allotted
1.	Recapitulation of Mendelian principles; Practical applications of genetics in brief	(02L)
2.	Classical concept of a gene: Allele, pseudoalleles, multiple alleles (blood groups)	(02L)
3.	Gene interactions and epistasis and their types.	(02L)
4.	Linkage and crossing over: 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)
5.	Quantitative genetics : Polygenic inheritance, heritability and its measurements and Quantitative Traits Locus mapping	(03L)
6.	Principles of Population Genetics: Hardy-Weinberg law and its application for autosomal genes. Calculations of gene frequencies with suitable examples.	(05L)
7.	Somatic cell genetics and its applications.	(02L)
8.	Microbial genetics : Methods of genetic transfers – transformation, conjugation, transduction	(03L)

9. Extra chromosomal inheritance: Inheritance of Mitochondria. (01L)
10. Human genetics: dominant and recessive disorders, physical traits. (04L)
- English in Scientific Communication:**
1. Language as a communication tool; relationship among reading, writing, listening and speaking (2L)
2. Pragmatic competence: co-operative principles and politeness principles (1L)
3. Organisation of English language: sentence structure, basic grammar, sequence and tenses, syntax, paragraphs, paraphrases and précis writing, synonyms and antonyms (3L)
4. Common errors in written and spoken English: tautology, double negative, double positive, superfluous words (2L)
5. Oral presentation: How to prepare a presentation, power point slides, use of communication and IT, voice, speed of delivery, obstacles in effective communication (2L)
6. Drafting of a research project for financial assistance from funding agency, writing of scientific paper using word processor. (2L)
7. Outline of a scientific research paper: (14L)
- 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.
- 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
8. Editing and correcting: proof-reading symbols, jargons and abbreviations (3L)
9. Plagiarism: meaning, types, avoiding plagiarism. (1L)

REFERENCE BOOKS:

1. Genetics, 3Rd Edn by Strickberger, Pearson India, 2015, Paperback, 9789332555105
2. Principles of Genetics, Gardner, E.J., Peter & Simmons, M.J. and Snustad, D.P. 8thEdn. 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, P.S. And Agrawal, V.K., S.Chand and Co., New Delhi
6. Genetics By Gupta, P.K., 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
10. O'Conner M. and F. P. Woodford (1975) Writing Scientific Papers in English. Elsevier-Excerpta Medica-North Holland Publ., Amsterdam.
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*. 2nd 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:

ZODT 114 Biostatistics (2 Credits= 30 lecturers)

Semester I

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

CO1: Explain the application of sampling in biological sciences.

CO2: Explain standard Probability distributions.

CO3: Explain the concept and types of central tendency.

CO4: Explain the concept of correlation and regression with their properties.

CO5: Classify the given data.

CO6: Graphically represent the given data.

CO7: Illustrate the measures of dispersion with examples.

CO8: Solve statistical problems.

Sr. No	Name of the topic	Lectures allotted
1.	Introduction: 1.1 Applications and Uses of Statistics 1.2 Population & sample, Different types of Sample 1.3 Exercise & Problems.	(02L)
2.	Data Classification: 2.1 Some important terms (Class frequency, class- limits, Class-width, class mark) 2.2 Frequency distribution, Cumulative frequency, Graphical representation of data (Histogram, Pie-Diagram, Ogive-Curve.) 2.3 Exercise & Problems	(3L)
3.	Measures of central tendency: 3.1 Concept of central tendency, Types of central tendency (Arithmetic mean, Median and mode) combined mean. 3.2 Partition values (Quartiles, Deciles, and Percentiles), Box plot. 3.3 Exercise & Problems.	(3L)
4.	Measures of dispersion: 4.1 Concept of dispersion, absolute and relative measure of dispersion. 4.2 Different measures of dispersion (Range, Quartile- Deviation, Variance and standard-deviation, Coefficient of Variation) combined variance 4.3 Exercise & Problems.	(4L)
5.	Correlation and Regression: 5.1 Bivariate data, concept of correlation, Types of Correlation, Scatter diagram, Karl Pearson's coefficient of correlation and its properties. 5.2 Concept of regression, Linear regression, regression Coefficients and its properties. 5.3 Exercise & Problems.	(5L)
6.	Probability and probability distribution: 6.1 Some important terms (types of experiment, sample Space and types of sample space, events and types of events.) 6.2 Definition of probability (mathematical and classical) Conditional	(5L)

probability. Concept of random variable Univariate Probability Distribution and its mathematical expectation.

6.3 Some standard probability distributions (binomial, Poisson and normal) their probability distribution, mean, variance, and properties of these distribution.

6.4 Exercise & Problems.

7. Test of hypothesis: (8L)

7.1 Some important terms (hypothesis, types of hypothesis, Test, Critical region, acceptance region, type I error, type II error, level of significance, p-value)

7.2 Test for mean and equality of two population means, Test for proportion and equality of two population proportions.

7.3 chi-square test for goodness of fit, Unpaired and paired t test. F test for equality of two population variances.

7.4 Software used for Statistical analysis

7.5 Exercise & Problems.

Course Code and Course Name:

ZODP 114 Practical Biostatistics.

(2 Credits- 60 Hours)

Semester I

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

CO1: Construct frequency distribution chart.

CO2: Graphically represent the given data.

CO3: Solve the statistical problems based on Central Tendency, Dispersion, Correlation and regression.

CO4: Apply computer software for statistical analysis.

CO5: Solve numerical problems on test of hypothesis using biological data.

Sr. No	ZODP 114 Practical Biostatistics	No. of Practicals
1.	Construction of frequency distribution and its graphical representation.	(1P)
2.	Measures of Central Tendency.	(2P)
3.	Measures of Dispersion	(2P)
4.	Correlation and Regression.	(1P)
5.	Computation and application of binomial & Poisson probabilities.	(1P)
6.	Computation and application of normal probabilities.	(2P)
7.	Test for means and proportions	(1P)
8.	Chi-square test of goodness of fit.	(1P)
9.	Paired and unpaired t- test, F-test.	(2P)
10.	Statistical analysis with Computer software packages	(2P)

REFERENCE BOOKS:

1. Principles and Practice of Biostatistics: Dr J.V. Dixit
2. Statistical Methods: Snedecor G.W. & Cochran W.G.
3. Statistical Methods: Dixon W.S. and Massey
4. Biostatistics for the Biological and Health Sciences, 2nd Edition
by Marc M. Triola, Mario F. Triola, Jason Roy, Published by Pearson
Copyright © 2018
5. Biostatistics: Basic Concepts and Methodology for the Health Sciences,
10ed, ISV by Wayne W. Daniel, Wiley Publication.

Course Code and Course Name:

ZODT 114 Freshwater Zoology.

(2 Credits= 30 lecturers)

Semester I

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.	Introduction to freshwater habitats. Lotic habitat: Major rivers in India Lentic habitat: Lakes, ponds, wetlands and ephemeral water bodies. Thermal stratification in lakes.	(02L)
2.	Physico-chemical conditions of freshwater and its implications on freshwater biota. Physical conditions: Water current, water colour, turbidity and temperature. Chemical conditions : pH, carbon dioxide, dissolved oxygen, hardness, acidity and alkalinity, nitrate, phosphate and sulphates.	(7L)
3.	General characters of plankton with special emphasis on the characters used in taxonomy and reproduction: Rotifera, Copepoda, Cladocera and Ostracoda.	(4L)
4.	Introduction to minor phyla: Gastrotricha, Bryozoa and Tardigrada (water bears).	(2L)
5.	Diversity and economic importance of freshwater Crustacea and Mollusca.	(2L)
6.	Locomotory and respiratory adaptation in freshwater insect orders: Ephemeroptera, Odonata, Plecoptera, Coleoptera, Diptera and Hemiptera. .	(2L)
7.	Diversity and distribution of vertebrates in the freshwater bodies of India. (Excluding fishes)	(2L)
8.	Adaptive physiology of freshwater fauna: Osmotic and ionic, thermal, respiratory, reproductive and life cycle, mechanical, locomotory and sensory adaptations.	(6L)
9.	Anthropogenic impact on freshwater: Waste and pollution, sewage and silage, mining waste, agricultural chemicals, industrial outflows and invasions. Eutrophication : Causes and problems.	(3L)

Course Code and Course Name:**ZODP 114 Practical Freshwater Zoology.****(2 Credits = 60 lectures.)****Semester I**

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

CO1: Identify commercially important freshwater fish.

CO2: Identify the aquatic adaptations in common freshwater forms.

CO3: Prepare the culture of *Paramecium* and *Daphnia*.

CO4: Estimate the hardness and chloride content in water samples.

CO5: Analyze the Zooplanktons from local freshwater bodies.

CO6: Evaluate the bio-indicators of pollution in freshwater.

Sr. No.	ZODP 114 Practical Freshwater Zoology	No. of Practicals
1.	Estimation of total carbon dioxide and chloride form given water sample.	(1P)
2.	Estimation of phosphates forms given water sample.	(1P)
3.	Estimation of total nitrate from given water sample.	(1P)
4.	Estimation of calcium and total hardness of given water sample.	(1P)
5.	Estimation of total alkalinity of given water sample.	(1P)
6.	Collection, preservation and identification of zooplankton from freshwater habitat. (Prepare permanent slides and Identify up to genus level using taxonomic key).	(2P)
7.	A qualitative and quantitative analysis of zooplankton from a given freshwater sample using Lackey's drop count method/ Sedgwick rafter counting cell.	(1P)
8.	Identification of economically important freshwater crustaceans and fishes.	(1P)
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>).	(1P)
10.	Study of aquatic and semiaquatic adaptations in amphibians and reptiles.	(1P)
11.	Estimation of primary productivity with dark and light bottle method	(1P)
12.	To prepare and maintain a culture of paramecium, Daphnia and Hydra	(2P)
13.	A Compulsory visit to local freshwater body and preparation of report on physicochemical conditions and faunal organisms.	(1P)

REFERENCE BOOKS:

1. Limnology: lake and river ecosystem, Robert G. Wetzel. Academic Press,

3rd edition.

2. Treatise of Limnology. Hutchinson G. E. John Willy 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:**ZOUP 115 Basic Zoology Lab-1.****(4 Credits- 120 hours)****Semester I**

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 developmental stages of chick embryo, cell structures and phases of cell division

CO2: Identify the grammatical mistakes from the given paragraph and common errors in written and spoken presentations.

CO3: Write a scientific project and research article along with its proof reading.

CO4: Demonstrate the working of different microscopes, colorimetric and spectrophotometric methods, cell fractionation and ligature in *Drosophila* larvae,

CO5: Determine the gene distance and order, genotype and phenotype ratios and allelic frequencies from the given data.

CO6: Estimate sugar and protein by suitable biochemical method, and isolate protein from biological source.

CO7: Prepare acid and base solutions of desired strength, buffers, bacterial Culture, chick embryo culture and *Drosophila* culture.

CO8: Prepare temporary slide of various cells to demonstrate the cell morphology and cell division, giant chromosome and pedigree analysis chart.

CO9: Calculate % retention and % elution of amino acids on given ion exchanger.

Sr. No.	Name of the Practical	No. of Practicals
Module-I Biochemistry and Biochemical Techniques		
1.	Preparation of Acid & Alkali solutions and acid-base titration (Compulsory)	1P
2.	Principle and working of Colorimetry and spectrophotometry	1P
3.	To prepare Buffers of known pH and molarity and measurement of pH of various samples, Buffering capacity	1P
4.	Units and specific activity of enzymes.	1P
5.	Effect of substrate concentration on enzyme activity (Compulsory)	1P

6	Determine the concentration of Vitamin C by titration method from various sources.	1P
7.	Estimation of Sugar (Glucose) by Folin Wu method. (Compulsory)	1P
8.	Isolate proteins by salting out / by adjusting isoelectric point. (Compulsory)	1P
9.	Estimation of protein by Biuret method method. (Compulsory)	1P
10	Principle and uses of different microscopes	1P
11	Principles of electrophoresis, separation of proteins using Gel electrophoresis. (Compulsory)	1P
12.	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	1P
13	To study the effect of different solvents for a given dye using thin layer chromatography (Compulsory)	1P
14.	Enzyme isolation and purification by fractionation methods.	2P
Module-II Cell Biology and Developmental Biology		
1	Study of ultrastructure of cell organelles. (Compulsory)	1P
2	Study of different types of cells. (Compulsory)	1P
3	Temporary preparation of human cheek epithelial cells. (Compulsory)	1P
4	Study of different stages of mitosis in suitable material. (Compulsory)	1P
5	Study of meiosis in Grasshopper testes / Onion flower buds / <i>Aloe vera</i> with emphasis on all stages of prophase. (Compulsory)	1P
6	Limits of cleanliness (To check for microbial flora)	2P
7	Cell fractionation – Nuclei, mitochondria observation, nuclear count.	2P
8	Mounting of chick embryos and preparation of permanent mounts (Compulsory)	1P
9	Filter paper ring method for <i>in vitro</i> culturing of chick Embryo & observations.	1P
10	Gross anatomy and histology of chick embryo upto 72 hrs. Brain, heart, lens, ear development. (Compulsory)	1P
11	Study of embryonic and post-embryonic development using frog egg as a model system.	1P
12	Study of life cycle of <i>Drosophila melanogaster</i> . (Compulsory)	1P
13	Study of effect of ligature in <i>Drosophila</i> / House fly larva	1P
14	Study of regeneration in <i>Hydra/ Planaria</i> .	1P

15	Study the early developmental stages in any freshwater snail.	1P
	Module-III Genetics and English in Scientific communication	1P
1	Study of sex linked inheritance in <i>Drosophila sp.</i>	1P
2	Study of monohybrid and Dihybrid ratio in <i>Drosophila sp.</i> (Compulsory)	1P
3	Determination of gene distances and gene order for a given three-point test cross. (Compulsory)	1P
4	Polytene chromosomes of <i>Drosophila or Chironomous</i> -examination of puff and bands. (Compulsory)	1P
5	Estimation of allelic frequencies, heterozygote frequencies in human populations. (Compulsory)	1P
6	Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive.	1P
7	Culturing <i>E.Coli</i> on solid and liquid media	1P
8	English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, pronoun (Compulsory)	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 (Compulsory)	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.	1P
17	Write discussion section for the given discussion-less research paperand writing Citations/ Bibliography (Compulsory)	1P
18	Oral presentation: Rhythm, style, control, mock presentation of 10 minutes.	1P

M.Sc. Zoology (Semester - 2)

Course Code and Course Name:

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.

Sr. No.	Name of the topic	Lectures allotted
1.	DNA structure and topology :-Structure of chromatin, nucleosome, chromatin organization and remodeling, higher order organization - chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin, type of DNA (A,B,Z)	(5L)
2.	Physical properties of DNA: T _m , hypo and hyper chromicity, solubility, mutarotation and buoyancy.	(2L)
3.	Genome organization: C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence and their importance Cot ½ and, kinetic and sequence complicity, satellite DNA.	(2L)
4.	DNA Replication: DNA replication in <i>E. coli</i> , Origin of replication, , types of <i>E. coli</i> DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle. Different models of replication for linear and circular DNA replication features of single stranded	(10L)

- phages. Eukaryotic DNA replication, multiplereplicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex(ORC), regulation of replication.
5. **DNA damage and repair:** Different types in DNA damages, Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair, Nick Translation and SOS Repair (5L)
 6. **Transcription:** Transcriptional Unit in prokaryotes and eukaryotes, role and significance of promoter, enhancer, intron, exon, silencer, Transcriptional factors, mechanism of prokaryotic gene transcription, type and structure of RNA polymerase, post transcriptional processing: Capping, polyadenylation and splicing in eukaryotes and significance, Ribonucleoproteins(SnRNPs&ScRNPs) (8L)
 7. **Gene regulation and expression** in prokaryotes- Lac, arabinose and Trp operon. (3L)
 8. **Protein synthesis:** Genetic Code ribosome structure, activation of amino acids, peptide bond formation and translocation of peptides, post-translational modifications, inhibitors of protein synthesis (6L)
 9. **Mobile DNA elements:** Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transposition Controlling elements in Tn A and Tn 10 transposition, SINES and LINES. Retroviruses and retrotransposon. (4L)
- Bioinformatics**
1. **Introduction** (2L)
Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, ExPASy, PubMed, OMIA), Applications of Bioinformatics
 2. **Databases – Tools and their uses** (4L)
Biological databases, Primary sequence databases, Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ), Protein sequence data bases (UniProtKB, PIR, PDB) Secondary sequence databases, Derived databases - PROSITE, BLOCKS, Pfam/ Prodom, Structure databases and bibliographic databases

- 3. Sequence alignment methods (4L)**
 BLAST, FASTA
 Significance of sequence alignment
 Pairwise sequence alignment (Needleman & Wunsch, Smith & Waterman methods) Multiple sequence alignment (PRAS, CLUSTALW)
- 4. Predictive applications using DNA and protein sequences (5L)**
 Evolutionary studies: Concept of phylogenetic trees, Parsimony and Bayesian approaches, synonymous and non-synonymous substitutions, convergent and parallel evolution, Pharmacogenomics: Discovering a drug: Target identification
 Protein Chips and Functional Proteomics: Different types of protein chip, detecting and quantifying; applications of Proteomics
 Metabolomics: Concept and applications

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. *Bioinformatics - A practical guide to analysis of Genes & Proteins*; Andreas D Baxevanis & B F Francis; John Wiley; 2000.
6. *Introduction to Bioinformatics*; 1st Edition; T K Attwood, D J parry-Smith; Pearson Education, 11th Reprint; 2005.
7. *Bioinformatics*; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003
8. *Bioinformatics sequence and genome analysis*; David W. Mount; Cold spring harbor laboratory press; 2004
9. *Basic Bioinformatics*; S. Ignacimuthu, S.J.; Narosa Publishing House; 1995

10. An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MIT Press, First Indian Reprint; 2005
11. Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003 (for the V unit)
12. Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce S. Lieberman; Wiley-Blackwell; 2011
13. Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well Publishing; 1998
14. Essential Bioinformatics; JinXiong; Cambridge University Press; 2006
15. Proteomics - From Protein Sequence to Function; 12 S. R. Pennington, M. J. Dunn; First edition; Springer publications; 2001
16. Proteomics; Timothy Palzkill; Springer; 2002
17. Metabolomics - A Powerful Tool in Systems Biology; Jens Hřiriis Nielsen, Michael C. Jewett; Springer; 2007
18. Systems Metabolic Engineering; Dr. Christoph Wittmann, Sang Yup. Lee; Springer; 2012
19. Bioinformatics (Bios Instant Notes); Second Edition (Special Indian Edition); T. Charlie Hodgman, Andrew French and David R. Westhead; Garland Science (Taylor and Francis Group); 2010
20. Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008
21. Bioinformatics Computing – The complete practical guide to bioinformatics for life scientists; Bryan Bergeron; Eastern Economy Edition; Prentice-Hall of India Pvt. Ltd., New Delhi; 2003
22. Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009
23. A text book of Molecular Biology- J.Pal and S. Ghaskadabi, Oxford Publication- India.
24. Freifelders Essentials of Molecular Biology, Malacinski G.M (2006) (Fourth Edition). Narosa Publishing House, New Delhi.
25. Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edition by Gerald Karp, Janet Iwasa, et al. 2016, Wiley Publication

Course Code and Course Name:**ZOUT 122 Endocrinology and Parasitology.****(4 Credits= 60 lecturers)****Semester II**

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

Endocrinology:

- CO1: Discuss the roles of Pituitary gland and pineal body.
 CO2: Explain hormonal regulation of biomolecules and mineral metabolism.
 CO3: Describe the role of osmoregulatory and gastrointestinal hormones.
 CO4: Explain the role of hormones in moulting, change in body colour of crustaceans; yolk synthesis in amphibians; insect development.
 CO5: Explain the hormonal regulation of metabolism.
 CO6: Illustrate the mechanism of hormone action and role of hormone receptors.
 CO7: Justify hormones as coordination molecules.
 CO8: Justify the significance of biological clocks and rhythms.

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.

Sr. No.	Name of the topic	Lectures allotted
Endocrinology:		
1.	Hormones as chemical messenger, types of hormones-protein and non-protein	(2L)
2.	Hormone receptors; on the plasma membrane, cytoplasm & nucleus	(2L)
3.	Mechanism of hormone action- signal transduction cascade.	(2L)
4.	Hypothalamic hypophysiotropins	(2L)

5. Adenohypophysial hormones: ACTH, PRL, STH and TSH (4L)
6. Control of chromatophores: Pituitary, pineal (2L)
7. Hormonal regulation of carbohydrates, protein & lipid metabolism: pancreatic hormones glucocorticoids (3L)
8. Osmoregulatory hormones: ADH, mineralocorticoids, renin-angiotensin (2L)
9. Gastrointestinal hormones (2L)
10. Control of calcium and phosphate metabolism (2L)
11. Endocrine mechanism in crustacean: X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction, colour change, moulting (3L)
12. **Chronobiology:** Introduction, significance, Clocks, Rhythm and Calendar, The biological timing system: Concepts and methods, Types: Ultradian, circadian and circannual rhythms. (4L)
- Parasitology**
- 1 **Host-Parasite systems:** (7L)
- 1.1 Preadaptation to infectiousness, Myiasis: Classification according to tissue, vectors specific, sub specific, accidental; clinical presentation humans, syndrome, symptoms, diagnostic, control method prevention, treatment.;
Transmission: Types, categories: A. Conspecific: Contact, Transplacental, Transovarian, B. Heterospecific: Mechanical (Indirect & Direct), Biological, Paratenic, Hyper parasitic, Parasitoidal.
- 1.2 Manipulation of Host behaviour, Parasitism & Altruism, parasites & social behavior of hosts, parasitism & life history, parasitic effects benefiting the host.
- 2 **Type study:** (8L)
- Classification geographical distribution, morphology, life-cycle, transmission, pathogenicity, treatment and prophylaxis of:
- 2.1 Protozoa: *Trypanosoma* Sps., *Leishmania* Sps.
- 2.2 Platyhelminthes: *Schistosoma* Sps., *Echinococcus* Sps.
- 2.3 Nematoda: *Ancylostoma* Sps., *Dracunculus* Sps.
- 3 **Genetics & Molecular Biology:** (7L)
- 3.1 *Trypanosoma*: Diploid & Sexual stage, Molecular characteristics of surface coat, Variable surface glycoprotein (VSG) and VSG gene expression.
- 3.2 *Plasmodium*: Diploid & haploid stages, Chromosome polymorphism, gene

encoding Circumsporozoite protein & merozoites S- antigens, surface antigen diversity. Resistance of Malaria to drugs, its mechanism & assessment.

3.3 Platyhelminthes: Inseminative behaviour, parthenogenesis and polyspermy, sex determination, sex linked inheritance in Schistosomes.

4 Serology & immunodiagnostic methods: (6L)

4.1 Serology & antibody synthesis, preparation & demonstration of specific antigens of *Entamoeba*, *Plasmodium*, *Trypanosoma* & *Leishmania*

4.2 Immunodiagnostic assays, Immunodiffusion, haemagglutination test, Radioimmuno assay, ELISA, complement fixation test.

5. Prophylaxis & control: Biologic, Genetic, Chemical, Physical & Other (2L) methods.

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 protozoology, Ecology, Physiology, Life history, Anderson, O.R., Springer verlag, Berlin.
9. General Parasitology, Cheng T. C., Academic Press.
10. Modern Parasitology, Cox F.E.G., Eds. Parasitology in focus, facts &

trends, Melhorn h.,Eds., SprigerVerlag, Beriin.

11. Medical Parasitology, Piakarsky G. L., Springer Verlag, Berlin.

12. Modern Parasitology, Cellular immunological & immunological aspects,
Wylor D. J., Eds.,

13. Molecular Parasitology: Protozoan parasites and their
MoleculesWalochnik, J, Duchene M, 2016

Course Code and Course Name:

ZOUT 123 Comparative Animal Physiology & Environmental Biology.

Semester II

(4 Credits= 60 lecturers)

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

Comparative Animal Physiology:

CO1: Explain the physiology of processes like digestion, respiration, muscle contraction and excretion.

CO2: Describe the mechanism of thermoregulation in both poikilotherms and homeotherms.

CO3: Explain the mechanism of chemical communication in vertebrates.

CO4: Comment on the structure and functions of various sense organs.

CO5: Illustrate the concept of osmotic regulation in various animals with suitable examples.

CO6: Compare the physiology of regulatory mechanisms in various groups of animals.

CO7: Justify the survival strategies of organism in varied climatic conditions.

CO8: Justify the evolution of various life processes in living forms.

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.

Topic No.	Name of the topic	Lectures allotted
1.	Digestion: Physiology of digestion.	(03L)
2.	Respiration: Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. Blood pigment, role in Oxygen transport. O ₂ dissociation curves physiological and ecological significance, CO ₂	(04L)
3.	Muscle contraction: Structure (light & electron microscopic) of the skeletal muscle, proteins of the myofilaments, nature of actin-myosin interaction, sarcoplasmic reticulum and role of Ca ⁺⁺ in contraction	(04L)
4.	Osmotic regulation: Concepts of osmole, osmolarity and tonicity, ionic regulation, Hyper- and hypo-osmotic regulators, ureosmotic animals.	(04L)
5.	Excretion: Basic processes in urine formation, renal function in animals specially the mammalian kidney, Renal pressure system, Comparative biochemistry of nitrogen excretion.	(04L)
6.	Thermoregulation: Biokinetic Zones, tolerance and resistance. Thermobiological terminologies. Compensatory patterns in poikilotherms. Critical temp, and zone of thermal neutrality. Mechanism of thermoregulation in homeotherms.	(04L)
7.	Chemical Communication: Neurosecretion, neurohemal & endocrine organs.	(03L)
8.	Sense organ: classification & functions (details of photoreception as a model). Reflexes, Principles of neural integration.	(04L)
Environmental Biology		
1.	Introduction: Fundamentals of Ecology, Ecosystems: Definition and, concept of ecosystems, energy flow in ecosystems, Nutritional Flux. Development and evolution of the ecosystems. Biogeochemical cycles, Food-chains, ecotone, edge effects, ecological niche, and ecosystem stability.	(5L)
2.	Environmental Microbiology: Microbes - classification and their	(2L)

applications in the environmental sciences. Cultivation and growth of microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents.

3. Biomes and Habitat Diversity: Classification of biomes, major biotic elements of each biome and their characteristics. Human impact on the natural environment. (2L)
4. Biological diversity of India: Definition and nature, India's biogeographically history, physiography, climate and its impact on biodiversity. Indian forest and vegetation types and diversity of flora and fauna. (4L)
5. Population and Community Ecology (2L)
6. Wetlands Forests and Semi-Arid Habitats of India: Definition and types of wetlands, important wetlands and their conservation issues. Forests and semi-arid habitats and their distribution in India, ecological status of forests and arid lands, and their conservation. (3L)
7. Endangered, Endemic and Extinct Species of India: Threatened species categories of IUCN, threatened species of animals and the reasons, Red data book, Biodiversity hotspots of India. (4L)
8. Wildlife management and conservation. Protected Areas Network in India: Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behaviour, food-habits, health, etc., tools for data collection and analysis. Human land-use and wildlife management units, important projects for the conservation of wildlife in India, Role of local communities in wildlife management. (6L)
9. Introduction to human animal conflict. (2L)

REFERENCE BOOKS:

1. Comparative animal physiology, Clifford Ladd Prosser, John Wiley & Sons
2. Animal physiology, Richard W. Hill, Gordon A. Wyse. Harper and Row

3. Comparative animal physiology, Philip Carew Withers, Saunders College Pub., 1992
4. Fundamentals of Ecology: E. P. Odum
5. Modern concepts in Ecology: H: D. Kumar
6. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. John Wiley and Sons.
7. Elements of Microbiology: Pelczar, M.J. and Chan ECS, McGraw Hill.
8. General Microbiology: Stainer, R.Y, Adelberg, EA and Ingraham, J.L. . Macmillan Press.
9. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. . Academic Press.
10. Microbiological Methods for Environmental Scientists and Enginners
11. Gaudy, A.F. and Guady, E.T. McGraw Hill.

Course Code and Course Name:

ZODT 124: Metabolic Pathways.(2 Credits= 30 lecturers)

Semester II

CO1: Define basic terminologies of metabolic pathways.

CO2: Explain the laws of thermodynamics, concept of free energy and ATP as currency molecule.

CO3: Describe the Concepts and regulation of metabolism.

CO4: Discuss the oxidation of fatty acids and its significance.

CO5: Illustrate the electron transport chain and oxidative phosphorylation.

CO6: Illustrate the reactions, energetics and regulation of glycolysis, glycogen biosynthesis, TCA cycle, Purine and Pyrimidine metabolism

CO7: Write the general reactions of various metabolic pathways.

CO8: Justify the role of enzymes in metabolism

Sr. No.	Name of the topic	Lectures allotted
1.	Basic law of thermodynamics, internal energy, enthalpy, entropy, concept of free energy, redox potentials, high energy compounds, structure and function of ATP.	(4L)
2.	Concepts of metabolism, Metabolic pathways-Catabolic and anabolic, regulation of metabolic pathways	(2L)
3.	Carbohydrate Metabolism <ol style="list-style-type: none"> 1. Steps of Glycolysis (EMP Pathway). 2. PFK 3. Regulation of Glycolysis. 4. Glycogenesis, Glycogenolysis and Glyconeogenesis 5. Inborn errors of metabolism- Von- Gerkes disease, Tarui's disease, Galactosemia, Maple syrup urine 	(7L)
4.	Electron transport chain and oxidative phosphorylation.	(3L)
5.	Citric acid cycle: Detailed study, energetics, regulation and significance, Role of PDH.	(4L)
6.	Oxidative degradation of amino acids: transamination, oxidative deamination.	(2L)
7.	Biosynthesis of purine and pyrimidine nucleotides	(3L)
8.	A Lipid metabolism: Introduction, oxidation of even chain saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, omega (ω)-oxidation of fatty acids, Ketogenesis. Transport of Fatty Acids.	(5L)

Course Code and Course Name:

ZODP 124: Practical in Metabolic Pathways.

(2 Credits- 60 Hours)

Semester II

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

CO1: Identify the common diseases/conditions caused due to errors in metabolism.

CO2: Explain the principle of Colorimetry and Spectrophotometry.

CO3: Use the basic equipment in biochemistry lab.

CO4: Illustrate the enzyme activity from suitable material.

CO5: Demonstrate the effect of various physical and chemical factors on enzyme activity.

CO6: Demonstrate the absorption studies of biomolecules.

CO7: Estimate the concentration of cholesterol, uric acid, amino acids and starch.

CO8: Separate biomolecules by chromatographic methods.

Sr. No.	ZODP 124: Practical in Metabolic Pathways.	No. of Practicals
1.	Estimation of Starch.(Compulsory)	(1P)
2.	Separation amino acids by paper chromatography	(2P)
3.	Estimation of uric acid in wall Lizard excreta/ Human blood any other suitable material.(Compulsory)	(1P)
4.	To find absorption spectrum of haemoglobin, BSA, Tyrosine.	(1P)
5.	Estimation of Protein by Lowry et al Method.(Compulsory)	(1P)
6.	Estimation of Sugar by DNSA method.	(1P)
7.	Separation of amino acids by TLC (Compulsory)	(1P)
8.	Estimation of free amino acids by Ninhydrin method.(Compulsory)	(1P)
9.	Estimation of cholesterol.	(1P)
10.	Study α -Amylase Activity in Germinating Seeds.	(2P)
11.	Determination of saponification value of a fat.	(1P)
12.	Study the effect of pH and temperature on enzyme activity.	(1P)
13.	Study of human diseases caused due to errors in metabolic pathways with the help of pictures/charts/models/laboratory reports.	(1P)

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, 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., (2010) 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. Biochemical Methods, 2018, S.Sadashivam, New Age International Pvt Ltd Publishers; Third edition.
 9. An Introduction to Practical Biochemistry, 2017, David Plummer, McGraw Hill Education; 3th edition.
 10. Medical Biochemistry, 2018- John W Baynes and Marek H. Dominiczak, Publisher- Elsevier; 5th edition.
 11. Harper's Illustrated Biochemistry, 2018, Victor W. Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony Weil, McGraw-Hill; Illustrated edition,
 12. Principles of Medical Biochemistry-2016, Gerhard Meisenberg, William H. Simmons, Elsevier; 4th edition.

Course Code and Course Name:

ZODT 124: Ichthyology(2 Credits= 30 lecturers)

Semester II

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

- CO1: Identify the common fishes in India.
- CO2: Explain the general characters and evolution of fishes.
- CO3: Explain the fish morphology and anatomical modifications.
- CO4: Illustrate the physiology of reproductive and endocrine organs in fish.
- CO5: Discuss the signs, symptoms and control measures of common diseases in fish.
- CO6: Justify the role of respiratory and excretory organs in survival of fishes.
- CO7: Classify fishes upto order level.
- CO8: Setup aquarium and manage it.

Topic No.	Name of the topic	Lecture allotted
1.	Introduction, general characteristics, evolutionary succession and fossil history of fishes. The early evolution of fishes: Chondrichthian fishes - Sharks, Skates and Rays.	(3L)
2.	Eschmeyer's classification of fishes and diagnostic characters up to orders (one major order from each class).	(4L)
3.	External morphology, body form, appendages, pigmentation, skin and scales.	(1L)
4.	Food and feeding habits, Digestive system and its anatomical modifications.	(2L)
5.	Respiratory mechanism: Respiratory gills and lungs. Accessory respiratory organs: Origin of air breathing organs; skin, buccopharynxopercular cavity and air bladder.	(2L)
6.	Circulatory system: Heart and accessory pumps.	(2L)
7.	Excretion and Osmoregulation: Glomerular and aglomerular kidneys; Nitrogen (ammonia, urea, TMAO) excretions. Water and salt balance in stenohaline and euryhaline fishes. Role of skin and gills.	(3L)
8.	Reproduction: Structure of gonads, gametogenic cycles; spawning.	(2L)
9	Nervous system and Sense organs: Organization of the central and peripheral nervous systems. Olfactory, taste buds, touch receptors, photoreceptors, lateral line and internal ear	(3L)
10	Endocrine system: Pituitary gland, urophysis, adrenal gland, gonads, and thyroid gland.	(2L)
11	Fish pathology: Signs of sickness and effects on fish; Pathological procedure for diagnosis of fish diseases, Symptoms and control measures of viral, bacterial, fungal, protozoan, worm and crustacean diseases.	(2L)
12	Ornamental Fish production and management: World trade of ornamental fishes. Different varieties of exotic and indigenous ornamental fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater aquarium. Water quality management. Water filtration system – biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decoratives. Aquarium fish feeds. Dry, wet and live	(4L)

feeds. Breeding and rearing of ornamental fishes. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

Course Code and Course Name:

ZODP 124: Practical in Ichthyology (2 Credits – 60 hours)

Semester II

Sr. No.	Name of the Practical	No.ofPracticals.
1.	Study of fish evolution with the help of charts/models/Pictures.	(1P)
2.	General external characters, fins and scales (permanent slides & temporary preparations and submission during examination).	(1P)
3.	Classification of fishes (one example from each order); use of diagnostic keys.	(2P)
4.	Length-weight relationship, condition factor, gonado-somatic index of any one fish species.	(1P)
5.	Adaptations of fishes (adhesive organs, accessory respiratory organs, stomachless fishes, spiral valve, electric organs and sense organs.)	(1P)
6.	Study of Weberian ossicles in Heteropneustes/ Labeo.	(1P)
7.	Anatomical observations, demonstration and detailed explanation of fish in general, Digestive, urino-genital system, Endocrine glands of carp/ catfish/ Tilapia.	(1P)
8.	Identification of fish developmental stages: egg, spawn, fry fingerling and adult.	(1P)
9.	Cranial nerves (V, VII, IX & X) and eye ball musculature and innervations in Scoliodon/ carp/ catfish.	(1P)
10.	Histology of digestive, respiratory, excretory, reproductive and endocrine organs.	(1P)
11.	Study of common diseases in fish their diagnosis and control strategies.	(1P)
12.	Setting up of an aquarium and its management and study of breeding behaviour of gourami, Siamese fighting and swordtail.	(2P)
13.	Visit to fish farm/ fish breeding centre/fish market and preparation of detail visit report.	(1P)

REFERENCE BOOKS:

1. Bal D. V. & K. V. Rao (1984). Marine Fisheries. Tata McGraw-Hill, New Delhi.
2. Bone Q., N. B. Marshall & J. H. S. Blaxter (1995). Biology of Fishes, Edn.2, Blackie, Academic % Professional (Chapman & Hall), London.
3. C. Vandujn. Diseases of fishes – Narendra Publishing House, New Delhi.
4. Hoar W. S. & D. J. Randall (1969). Fish Physiology. Vols. I onwards, Academic Press, New York.
5. Jayaram K. C. (1981). The freshwater fishes of India. Pakistan, Bangladesh, Burma and Sri Lanka- A Handbook. Zool. Survey of India, Academic Press, New York.
6. Khanna, S. S. (1984). An Introduction to Fishes. Central Book Depot., Allahabad.
7. Lagler K. E., J. E. Bardach, R. R. Miller D.R.M. Passino (1977). Ichthyology, Edn.2, Wiley, New York.
8. Rahul P. Parihar. Textbook Of Fish Biology & Indian Fisheries
9. Talwar P.K. & A.G. Jhingran (1991). Fish and Fisheries of India and Adjacent Countries, Vols. I & II. Oxford & I.B.H., New York.
10. Wake, M.H. (Ed.) (1979). Hyman's Comparative Vertebrate Anatomy. Edn.3, University of Chicago Press, Chicago
11. Wedemeyer G. A. Environmental stress and fish diseases –Narendra. Publishing House.
12. William N. Eschmeyer (2019). Eschmeyer's Catalog of Fishes (Vol. 1, 2 & 3). Published by the California Academy of Sciences, San Francisco © 1998.

Course Code and Course Name:**ZOUP 125 Basic Zoology Lab-2(4 Credits, 120 hours)****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, thyrodectomyand pancreactomy.

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 aquatic animal.

CO7: Determine the bleeding and clotting time, heartbeat of crab, species richness in selected 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 and construct phylogenetic tree using tools inbioinformatics.

Sr. No.	Name of the Practical	No. of Practicals
Module-I Molecular Biology and Bioinformatics		
1.	Lab Safety Techniques and sterilization.	1P
2.	Isolation of bacterial DNA and estimation by UV spectrophotometry (Compulsory)	2P
3.	Isolation of Liver DNA and quantification, Agarose gel electrophoresis of isolated DNA.(Compulsory)	2P
4.	Isolation of RNA and agarose gel electrophoresis.	1P
5.	Concept of biological database, gene and protein search by BLASTA and	1P

	FASTA (Compulsory)	
6	To analyse protein on native PAGE and SDS-polyacrylamide gel electrophoresis.(Compulsory)	2P
7.	Construction of phylogenetics tree for DNA and protein (Compulsory)	1P
8.	Demonstration of DNA amplification by PCR	1P
	Module- II Endocrinology and Parasitology	1P
1	Histology of invertebrate and vertebrate neurosecretory and endocrine structures.(Compulsory)	1P
2	Blood sugar regulation in the crab- role of eye stalk. (Compulsory)	1P
3	Study of retrocerebral complex of the cockroach.	1P
4	Introduction of alloxan diabetes in the mouse/ rat / human. (Compulsory)	1P
5	Gonadectomy in the mouse/ rat.	2P
6	Pancreatectomy in the mouse/ rat.	1P
7	Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human. (Compulsory)	1P
8	Thyroidectomy in the rat.	1P
9	Study of life cycle, role as vector & control measures of: Ticks(<i>Argas, Boophilus</i>) Mosquito – any two from- <i>Anopheles/ Aedes/ Culex</i> Any two flies: <i>Tabanus/ Phlebotomus/ Sarcophaga</i> .Cyclops. (Compulsory) (Specimen, Slides or charts may be used.)	2P
10	Ectoparasites&Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta.	2P
11	Study of life cycle of parasitic protozoa: <i>Trypanosoma, Leishmania</i> .(Compulsory)	1P
12	Study of life cycle of helminth parasites: <i>Schistosoma, Echinococcus, Ancylostoma, Dracunculus</i> (Compulsory)	2P
13	Study of Parasites from digestive tract of Cockroach/gut / parasites of hen. (Compulsory)	1P

Module-III Comparative Animal physiology and Environmental Biology		
1	Study of nitrogenous waste products of animals from different habitats. (Compulsory)	1P
2	Study of RBCs in different vertebrates and in different physiological conditions.	1P
3	Study of relation of Body size and oxygen consumption in aquatic animals (crab/fish). (Compulsory)	1P
4	Estimation of sugar in rat/crab/human blood. (Compulsory)	1P
5	Determination of bleeding time & clotting time of human blood. (Compulsory)	1P
6	Determination of the heart beat in the crab-effect of temperature & ions.	1P
7	Effect of eye stalk ablation on glucose in the haemolymph of the crab.	1P
8	A visit to aquatic ecosystem and methods for water and plankton collection. (Compulsory)	2P
9	Plankton identification and quantification from river / lake water samples. (Compulsory)	2P
10	Vegetation studies by line, quadrates and belt transect methods and their analysis.	2P
11	Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples. (Compulsory)	2P
12	Water analysis for physico-chemical characteristics. (Compulsory)	1P
13	Physico-chemical analysis of soil. (Compulsory)	1P

Note: Latest edition of the recommended books may also be used