Rayat Shikshan Sanstha's

R. B. Narayanrao Borawake College, Shrirampur (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Department of Zoology

M.Sc. I (Zoology) Syllabus as per NEP-2020

Implemented

From

Academic Year: 2023-24

Course Structure of M. Sc. I (Zoology)
(Semester-I)

Year	Semester	Course Type	Course Code	Course Title	Theory/ Practical	Credits	No. of Lectures/ Practicals	Page No.
1st	I	Major Core	ZO-MJ-511T	Advanced Biochemistry	Theory	2	30L	4-5
			ZO-MJ-512T	Advanced Cell Biology	Theory	2	30L	6-7
			ZO-MJ-513T	Comparative Embryology	Theory	2	30L	8-9
			ZO-MJ-514T	Medical Entomology	Theory	2	30L	10-11
			ZO-MJ-515T	English in Scientific Communication	Theory	2	30L	12-13
			ZO-MJ-516P	Lab. Exercise in Biochemistry and Cell Biology	Practical	2	14P	14-15
			ZO-MJ-517P	Lab. Exercise in Medical Entomology and English in Scientific Communication	Practical	2	12P	16-17
		Major Elective	ZO-ME-518AT	Animal Behavior	Theory	2	30L	18-19
			ZO-ME-518BT	Fresh water Zoology	Theory	2	30L	20-21
			ZO-ME-519P	Lab. Exercises in Fresh Water Zoology	Practical	2	12P	22-23
		Research Methodology	ZO-RM-520T	Research Methodology	Theory	4	60L	24-26

Course Structure of M. Sc. I (Zoology) (Semester-II)

Year	Semester	Course Type	Course Code	Course Title	Theory/ Practical	Credits	No. of Lectures/ Practicals	Page No.
1st	II	Major Core	ZO-MJ-521T	Molecular Biology	Theory	2	30L	28-29
			ZO-MJ-522T	Comparative Endocrinology	Theory	2	30L	30-31
			ZO-MJ-523T	Comparative Animal Physiology	Theory	2	30L	32-33
			ZO-MJ-524T	Biochemical Techniques	Theory	2	30T	34-35
			ZO-MJ-525T	Integrated Pest Management	Theory	2	30T	36-37
			ZO-MJ-526P	Lab. Exercise in Molecular Biology and Biochemical Techniques	Practical	2	15P	38-39
			ZO-MJ-527P	Lab. Exercise in Comp. Animal Physiology and Comp. Endocrinology	Practical	2	15P	40-41
		Major Elective	ZO-ME-528AT	Medical Parasitology	Theory	2	30L	42-43
			ZO-ME-528BT	Metabolic pathways	Theory	2	30L	44-45
			ZO-ME-529P	Lab Exercises in Metabolic Pathway	Practical	2	13P	46-47
		OJT/FP	ZO-OJT-530P	On Job Training	Training	4	--	48-49

Syllabus for M. Sc. I (Zoology)

Semester I

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-511T):
Advanced Biochemistry

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-511T - Advanced Biochemistry	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand concept of bio molecules, its importance and explain types of bio molecules in biological system.
- Use a variety of models to understand and explain chemical and biochemical phenomena, being aware of their strengths and weaknesses.
- Understand lipid metabolism and its importance. Compare mitochondrial and peroxisomal systems of fatty acid oxidation.
- Develop effective and safe chemical and biochemical laboratory skills that require use of the methods and instrumentation of modern biochemistry.

COURSE OUTCOMES:

At the end of this course, a student will be able to:

CO1: Outline concept of bio molecules, its importance and explain types of bio molecules in biological system. Describe structure and properties of proteins, DNA and RNA.

CO2: Classify types of enzymes and explain effect of various factors on enzymatic reaction.

CO3: Illustrate the metabolism of carbohydrates and proteins.

CO4: Explain Lipid metabolism and its importance. Compare mitochondrial and Peroxisomal Systems of fatty acid oxidation.

SYLLABUS of ZO-MJ-511T: [30 Hours]

Unit-1: Introduction to Biochemistry [07 Hours]

Basics of chemistry: Structure of atoms, molecules and chemical bonds, Normality, Molarity, Molality**.** Chemistry of Water: Structure of water and physico-chemical properties of water, water as universal solvent, pH and Buffers, Biological Buffer System.

Unit-2: Carbohydrates and Lipid: [07 Hours]

Carbohydrates: Classification, basic structures and functions, Biological Significance. Lipids: Classification, structure and function and biological significance.

Unit-3: Vitamins, Protein, and Amino acid: [08 Hours]

Vitamins- Classification- water-soluble and fat-soluble vitamins, Biological significance.

Amino acids: Classification, properties (Physical properties- Optical Isomerization, Absorption in UV light, Ionization; Chemical properties-reactions with carboxyl group and amino group) 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. Structures with examples, Biological significance of proteins.

Unit-4: Enzymes: **[08 Hours]**

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

ESSENTIAL/RECOMMENDED READINGS

1. Biochemistry–Lehninger.
2. Metabolic Pathways -Greenberg.
3. Biochemistry– G. Zubay, Addision Wesley Publ.(1983).
4. Biochemistry–Stryer(1988)3rd EditionW.H. Freeman and Co.
5. Berg J. M. Tymoczko J. Land Stryer L. (2011) Biochemistry, W. H. Freeman and Company.

Website Resources:

1. https://metacyc.org/MetaCyc is a database of experimentally elucidated metabolic pathways.
2. https://biocyc.org/: Bio Cyc is a collection of more than 20 thousand for model eukaryotes and for thousands of microbes, plus software tools for exploring the biochemical world.

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-512T):
Advanced Cell Biology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-512T - Advanced Cell Biology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Learn the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- Be aware of how these cellular components are used to generate and utilize energy in cells.
- Understand the cellular components underlying mitotic cell division.
- Recognize the types, development and causes of tumour.

COURSE OUTCOMES:

At the end of this course, a student will be able to-

CO1: Label the various cell parts and sketch and label various types of cells and cell organelles.

CO2: Explain carbon as backbone of bio molecules and explain the ultra-structure and functions of various cell organelles.

CO3: Explain the concepts of cell signaling and illustrate the chemistry and organization of cytoskeleton.

CO4: Illustrate the types, development and causes of tumor and diagrammatically represent the cell cycle phases and its regulation.

SYLLABUS of ZO-MJ-512T: [30 Hours]

Unit-I: Overview of Cells and Cell Research: **[08 Hours]**

Cell as experimental model, Tools of cell biology. Biology of Cell Membranes: Chemical composition cell membranes, membrane receptors transport across the membrane, Membrane potentials and nerve impulses, Extra cellular matrix; cell-matrix adhesion (integrins, collagen and non-collagen compounds Cell-cell interaction adhesion junction, tight junction, gap junction and plasma-desmata; Ca^{++} dependent and Ca^{++} independent cell-cell adhesion.

Unit-II: Protein sorting: **[07 Hours]**

Protein uptake into the ER, Membrane Proteins and Golgi sorting Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway. Structural and functional

organization of intracellular organelles: Nucleus, Mitochondria, Golgi body, Lysosomes, ER and Peroxisomes, Vacuoles, Chloroplast.

Unit-III: Cytoskeleton and cell movement [08 Hours]

Structure and organization of actin filaments, Actin, Myosin and cell movements. Structure and dynamic organizations of microtubules, Microtubule motors and movement, Intermediate filaments, Cilia and flagella. Cell-Cell Signaling-Signaling molecules and the receptors. Function of cell surface receptors. Pathways of intra cellular signal transduction, Signaling networks.

Unit-IV: Regulation of cell cycle and check-points, Cell Death [07 Hours]

Necrosis, programmed cell death (Intrinsic and Extrinsic pathway). Cell Renewal: Stem cells applications. Biology of Cancer: The development and causes of cancer. Oncogenes, Tumors suppressor genes, Molecular approaches to cancer treatment.

ESSENTIAL/ RECOMMENDED READINGS:

1. Cell Biology, 6th Edition, Karp Gerald, John Willey & Sons (Asia) Pvt. Ltd. (2010).
2. The Cell : A Molecular Approach, Cooper Geoffrey M. A.S.M.Press, Washington D.C., U.S.A. (1997).
3. Cell Biology – Organelle Structure and Function, Sadava David E. Jones & Barlett Publishers, Boston, London. (1993).
4. World of the Cell, 8thEdition, Hardin Jeff, Gregory Bertoni and Lewis J. Klein smith, Pearson Education, Inc., San Francisco, U.S.A. (2012).
5. Molecular Biology of the Cell, 5th Edition, Alberts B., A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter Garland Science, New York, U.S.A. (2008)

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-513T):
Comparative Embryology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-513T - Comparative Embryology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand the terms in developmental biology and model organism for developmental studies.
- Differentiate the types of eggs, concept of fertilization and cleavage pattern.
- Find out neural competence and induction, concept of growth and differentiation.
- Familiar to compare and contrast Spermatogenesis and Oogenesis.

COURSE OUTCOMES:

At the end of this course, a student will be able to**:**

CO1: The course gives detailed idea about advantage in the area of clinical embryology.

CO2: Know basic definitions and concepts in embryology.

CO3: Understand concept of fertilization and how internal and external fertilization ensures species specificity.

CO4: Differentiate types of egg and cleavage patterns according to developmental need of embryo and processes of blastulation.

SYLLABUS of ZO-MJ-513T: [30 Hours]

Unit-1: Introduction to developmental biology- [7 Hours]

Early theories of Developmental biology concepts of Developmental biology -Growth, cell division, cell differentiation, cell communication, signaling, patterning, induction and competence. Model Organisms: Invertebrate: *Drosophila melano gaster*, Pisces: Zebra Fish- *Danio rerio*, Amphibians: *Xenopus laevis*, Birds: Chicken, Mammals: Mouse.

Unit-2: Gametogenesis and Fertilization: [8 Hours]

Spermatogenesis: spermatogenesis, structure of sperm, and regulation of sperm motility, Oogenesis: structure of ovum, pre vitellogenesis, vitellogenesis and post-vitellogenesis.

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.
Types of eggs: Based on amount of distribution of yolk, Cleavage: types and significance

Unit-3: Morphogenesis: [7 Hours]

Blastulation: Amphioxus, Frog, Chick, Mid Blastula Transition, Comparative study of Gastrulation in Amphioxus, Frog, Chick, and Neurulation: Frog, Chick.
Organogenesis: Development of the vertebrate eye - formation of eye field, cell differentiation.

Unit-4: Pattern formation: Setting up the body axis [8 Hours]

1. Animal vegetal axis: Amphibians,
2. Dorsal ventral axis: Amphibians
3. Antero-posterior axis: *Drosophila*-role of bicoid-nanos hunchback

Regeneration: Limb regeneration: Salamander, Regeneration in Hydra Apoptosis, aging and senescence

ESSENTIAL/ RECOMMENDED READINGS:

1. Developmental Biology, 12th edition, Michael J Barresi and S.F. Gilbert. Publisher - Sinauer, Associates Inc. (2020).
2. Principles of Development, 5th edition, Lewis Wolpert, Publisher-Oxford, University Press. (2018).
3. An Introduction to Embryology, 5th edition, B. I. Balinsky. Publisher –Thomas Asia Pvt. Ltd.(2004).
4. Developmental Biology, R. M. Twyman, Publisher -Bios Scientific, Publishers Ltd.(2001).
5. Analysis of Biological Development, 2nd edition, Klaus Kalthoff, Mc Graw Hill Science/Engineering/Math.(2000).

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-514T):
Medical Entomology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-514T - Medical Entomology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To understand the scope of Entomology and general characters of Insects.
- To study the morphology and anatomy of Insects.
- To learn the concept of social organization in Insects and household Insects.
- To study the economically important insects and pest management of harmful insects.

COURSE OUTCOMES:

At the end of this course, a student will be able to**:**

CO1: Understand, classify, and identify insects of medical and veterinary importance.
CO2: Incorporate the subject knowledge in designing innovative techniques of vector control.
CO3: Better prepared to contribute to the field of public and community health.
CO4: Understand molecular aspects of diseases of medical importance.

SYLLABUS of ZO-MJ-514T: [30 Hours]

Unit-1: Introduction to Medical Entomology - [8 Hours]

History, importance, need and scope. Importance of insects in relation to human health: Annoyance, Entomophobia, Myaisis, Envenomization, Allergies, Urtication, Blistering, Injuries to sense organs. Modes of transmission of insect borne diseases: Mechanical transmission and biological transmission. Parasitism in insects: Ectoparasitic, Endoparasites, vector-parasite relationship.

Unit-2: Vector Insect Biology: [7 Hours]

Systematics, morphology, life cycle, medical importance and control measures of:
Order–Diptera: Forest fly (*Hippobosca* sp.), Mosquito (*Anopheles* sp.).
Order–Siphonaptera: Cat flea (*Ctenocephalides felis*), Oriental rat flea *(Xenopsylla cheopis).*
Order–Psocodea: Head louse (*Pediculus humanus*), Pubic louse, (*Phthirus pubis).*
Order–Hemiptera: Reduviid bug (*Panstrongylus* sp.), bedbug (*Cimex lectularius*).

Unit-3: Insect Borne Diseases in Human: [8 Hours]

Mode of transmission, pathogenecity, prophylaxis, and control measures of Protozoan diseases: Leishmaniasis, Malaria.Viral diseases: Dengue fever, Japanese encephalitis. Bacterial disease: Bubonic plague, Bartonellosis. Rickettsiosis: Epidemic and endemic typhus. Helminthiasis: Filariasis.

Unit-4: Arthropods of Veterinary and Medical importance: [7Hours]

Introduction to arachnids of medical importance with respect to Morphology, life cycle, medical/ public health significance. Ticks: Soft ticks and hard ticks, Mites.

Forensic Entomology: Introduction to forensic entomology. Study of forensic insects: Life history, and importance in forensic investigations: Blow flies, Flesh flies, House flies, Carrion beetle, Rove beetle, Scarab beetles, Dermestid beetle, Sap beetle. Vector surveillance and Vector control**:** Methods and techniques of vector surveillance. Vector incrimination. Vector control: a) Mechanical methods, b) Ecological control, c) Chemical methods, d) Genetic control, e) Integrated vector management.

ESSENTIAL/RECOMMENDED READINGS:

1. Social Insects: Their Origin and Evolution, 2006, W. M. Wheeler, Discovery Publishing House, Delhi
2. Lives of Social Insects, 1968, P. P. Larson, M. W. Larson, World Pub. Co.
3. Handbook of medical entomology, Riley W. A., Johannsen O. A., Comstock Pub., New York.
4. Medical and Veterinary Entomology, 1995, 2nd Edn., Kettle D. S., CABI, UK
5. Medical Entomology A Textbook on Public Health and Veterinary Problems Caused by Arthropods 2nd Edition, Hardbound by B. F. Eldridge, J.D. Edman, Springer. (2003).
6. A History of Public Health, Rosen, G. New York: MD Publications. (1958).
7. World Health Organization, “Constitution of the World Health Organization, Chronicle of the World Health Organization (1947).

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-515T):
English In Scientific Communication

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-515T - English in Scientific Communication	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Infer the title, abstract, discussion and citations of a given scientific article.
- Explain language as a tool for effective scientific communication.
- Aware use the formal elements of specific types of scientific writing.
- 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.

COURSE OUTCOME:

At the end of this course, a student will be able to**:**

CO1: Write the outline of a scientific paper, the title, abstract, discussion and citations of a given scientific article.

CO2: Prepare a scientific presentation using PowerPoint.

CO3: Explain language as a tool for effective scientific communication.

CO4: Critically analyze data from research; incorporate it into assigned writing clearly, concisely, logically and attribute the source with proper citation.

SYLLABUS of ZO-MJ-515T: [30 Hours]

Unit-1: Language as a communication tool: [7 Hours]

Relationship among reading, writing, listening and speaking.

Pragmatic competence: co-operative principles and politeness principles.

Organization of English language: sentence structure, basic grammar, sequence and tenses, syntax, paragraphs, paraphrases and précis writing, synonyms and antonyms.

Unit-2: Common errors in written and spoken English: **[8 Hours]**

Tautology, double negative, doubles positive, superfluous words.

Oral presentation: How to prepare a presentation, power point slides, use of communication and IT, voice, speed of delivery, obstacles in effective communication. Drafting of a research project

for financial assistance from funding agency, writing of scientific paper using word processor.

Unit-3: Outline of a Scientific Research Paper: **[7 Hours]**

Hypothesis, theory and concept, Title designing, framing Abstract and Keywords, Introduction: statement of the problem and justification; aim, objectives, need, significance and rationale of the study, review of literature. Materials and Methods: contents, importance of measurements, reproducibility etc.

Unit-4: Observations and Results: **[8 Hours]**

Text and data presentation, tables, graphs, histograms, diagrams, photographic plates, legends and captions. **Discussion:** logical sequence and critical analysis of ideas and evidences, data conclusion. **References:** finding references from journals, books and databases; Citation - styles of citations Summary, Acknowledgement. Editing and correcting: proof-reading symbols, jargons and abbreviations. **Plagiarism:** meaning, types, avoiding plagiarism.

ESSENTIAL/RECOMMENDED READINGS:

1. Conner M. and F. P. Woodford (1975) Writing Scientific Papers in English. Elsevier-Excerpta Medica-North Holland Publ., Amsterdam.
2. Trelease S. F. (1958) How to Write Scientific and Technical Papers. Williams and Wilkins Co. Baltimore, U.S.A.
3. Day Robert (1996) How to Write and Publish a Scientific Paper. Cambridge University Press.
4. Mc Millan V. (1997) Writing Papers in the Biological Sciences. Edn.2, W. H. Freeman, New York.
5. Winkler Anthony C. and Jo Ray Mc Cuen-Metherell (2008) Writing the Research Paper, A Handbook. 7th Edition, Wadsworth Cengage Learning, Boston, M.A., U.S.A.

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-516P):
Lab. Exercise in Biochemistry and Cell Biology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-516P - Lab. Exercise in Biochemistry and Cell Biology	2	--	**2**

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Know standard laboratory practices and techniques of sterilization and of equipment's.
- Get knowledge of different biomolecules by qualitative and quantitative methods
- Prepare the buffers of any pH and molarity and measurement of pH of various samples.
- Understand anatomical/ histological features and interpret clinical conditions of hormones.

COURSE OUTCOMES:

At the end of this course, a student will be able to**:**

CO1: Describe concept of standard laboratory practices and techniques of sterilization and of equipment's.

CO2: Estimate different biomolecules by qualitative and quantitative methods.

CO3: Carry out and examine enzyme reaction and compare the effect of temperature and pH on enzyme activity.

CO4: Preparation of buffers of given pH and molarity and measurement of pH of various samples.

SYLLABUS of ZO-MJ-516P (14 Practicals):

1. Standard Laboratory Practices and techniques-Sterilization, Calibrations of measuring glassware and equipment, centrifuge, micropipettes, hot air oven, incubators, BOD, etc.
2. Preparations and standardization of different acid and bases**. (Compulsory)**
3. Estimation of Proteins.
4. Estimation of cholesterol.
5. Effect of substrate concentration on enzyme activity. **(Compulsory)**
6. Estimation of amino acids by paper chromatography. **(Compulsory)**
7. Estimation of amino acids by TLC. **(Compulsory)**
8. Preparation of mitotic chromosomes. **(Compulsory)**
9. Preparation of meiotic chromosomes.

10. Mitosis: Effect of colchicines on mitosis and polyploidy.
11. Study of phagocytosis and pinocytosis. **(Compulsory)**
12. Study of Cyclosis in Paramecium. **(Compulsory)**
13. Study of meiosis in grasshopper testis/ onion flower buds with emphasis on all stages of prophase. **(Compulsory)**
14. Preparation of blood smears: Cell type identification and differential count. **(Compulsory)**

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-517P):
Lab. Exercise in Medical Entomology and English in Scientific Communication

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-517P - Lab. Exercise in Medical Entomology and English in Scientific Communication	2	--	**2**

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Know concept of inter-relationships of insects and man.
- Understand different household insect in relation to human health.
- Identify the grammatical mistakes from the given paragraph and common errors in written and spoken presentations.
- Write a scientific project and research article along with its proof reading.

COURSE OUTCOMES:

At the end of this course, a student will be able to**:**

CO1: Describe concept of inter-relationships of insects and man.
CO2: Estimate different household insect in relation to human health.
CO3: Prepare temporary mount mouth parts of harmful insects.
CO4: Identify the grammatical mistakes from the given paragraph.

SYLLABUS OF ZO-MJ-517P (12 Practical)

1. Study of inter-relationships of insects and man.
2. Study of household insects in relation to human health of social insects- honey bee and termites.
3. Temporary preparation of mouth parts of harmful insect's mosquito, bed bug and house fly. **(Compulsory)**
4. To study control methods of harmful insects with suitable examples (biological control measures, repellents, fumigation, dusting, netting). **(Compulsory)**
5. Study of Social organization in: ant, wasp and termite**. (Compulsory)**
6. English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, and pronoun. **(Compulsory)**
7. Syntax, paraphrasing and précis writing, synonyms, antonyms, abbreviations. **(Compulsory)**

8. Spoken English: pronunciation, diphthong, accent, clarity, speed, punctuation, simplicity and syntax.
9. Common errors in written and spoken presentation- Tautology, double negatives and double positives, sequence and tenses, ambiguity, spellings, jargons.
10. Outline of a scientific paper; preparation of a research project. Writing abstracts conclusion / summary and acknowledgements, key words and suggests a suitable title to the given abstract/paper. **(Compulsory)**
11. Study of proof correction symbols; proof- reading the given text & correcting the proofs. **(Compulsory)**
12. A Compulsory visit to Field /Tour report.

MAJOR ELECTIVE COURSE (ZO-ME-518AT): Animal Behaviour

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-ME-518AT - Animal Behavior	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand the behavioural genetics and social behaviour of animals.
- Acquire knowledge of how language evolved in primates and different modes of communication.
- Understand different behavioural patterns of animals to study and analyses animal psychology.
- Understand reproductive behaviour: biological rhythms circadian and circannual rhythms.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Describe the behavioral genetics and social behavior of animals.

CO2: Explain and discuss how language evolved in primates and different modes of communication.

CO3: Illustrate the role of nerves and hormones in controlling behavior.

CO4: Classify different behavioral patterns of animals to study and analyses animal psychology.

SYLLABUS OF ZO-ME-518AT: [30 Hours]

Unit-I: Animal Psychology and Behavioural Genetics [07Hours]

Animal Psychology: Classification of behavioral patterns. Analysis of behavior (echogram). Innate behavior. Behavioral Genetics: Genes and behavior, evaluation of behavior, co-evolution, control of behavior: Neural and hormonal.

Unit-II: Communication and Social Behaviour [07 Hours]

Communication: chemical, visual, audio evolution of language (primates).

Social Behavior: aggregation, schooling in fishes, flocking in bird's group selection, kin selection, altruism, social organization in insects and primates.

Unit-III: Reproductive Behaviour [08 Hours]

Reproductive Behavior: mating systems, courtship, Sperm competition, parental care.
Biological Rhythms: circadian and circannual rhythms, orientation and navigation. Migration of fishes & birds. Learning and memory: In sight learning, Association learning, reasoning, cognitive skills.

Unit-IV: Application **[08 Hours]**

Applications: -application of animal behavior, approaches and methods in study of behavior.
Molecular applications – proximate and ultimate causation; altruism and evolution group selection, kin selection, reciprocal altruism; neural basis of learning, memory, cognition, sleep and arousal; biological clocks, Molecular basis of memory.

ESSENTIAL/RECOMMENDED READINGS:

1. Alocock, J. Animal behaviour: An evolutionary approach, Sinauer Assoc., Sunderland, Mass. USA.
2. Bradbury J.W. and S. L. Verhren camp. Principles of Animal Communication, Sinauer Assoc.
3. Clutton-Brock T.H. The evolution of Parental care, Princet on Univ. Press, Princet on, NJ, USA.
4. Eibl- Eibes feldt, I. Ethology. The biology of behaviour, Holt, Rinechart & Winston, New York.
5. Gould J.L. The mechanisms and evolution of behaviour.
6. Hauser, M. The evolution of communication, MIT Press, Cambridge, Mass.USA.
7. Hinde R.A. Animal behaviour: A synthesis of Ethology and Comparative psychology. Mc Graw-Hill, New York

MAJOR ELECTIVE COURSE (ZO-ME-518BT):
Fresh Water Zoology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-ME-518BT - Fresh Water Zoology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Illustrate the physical and chemical properties of water.
- Get introduced to the freshwater ecosystems.
- Acquire first-hand experience of the aquatic biodiversity.
- Acquire skills to critically evaluate scientific aspects of Freshwater Zoology.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Introduced with the current issues of the subject.
CO2: Get aware with the threats and an opportunity to resolve the issues related to Fresh water.
CO3: Get knowledge about physical and chemical properties of water.
CO4: Get known about Zonation in lakes and importance of freshwater habitats.

SYLLABUS of ZO-ME-518BT: [30 Hours]

Unit-I: Introduction to Fresh water Zoology [07 Hours]

Freshwater habitats: Lentic, lotic and ephemeral. Zonation in lakes: Littoral, limnetic and benthic, Light zones -photic, aphotic; Temperature zones -epilimnion, hypolimnion, thermo cline. The importance of fresh-water habitats.

Unit-II: Water as Medium of Life [06 Hours]

Water as Medium of Life: (Physical and chemical properties of water): Implications of physical and chemical conditions of water on freshwater fauna. Temperature, transparency, hardness, pH, dissolved oxygen and chloride.

Unit-III: Introduction to Fresh Water Fauna: [08 Hours]

Introduction to Freshwater Fauna: (Study of habitats, general and distinguishing features, ecological and economic importance) Zooplankton: Rotifera, Cladocera and Copepoda. Meiobenthic: Gastrotricha and Tardigrada. Fauna of temporary water bodies: Large Branchiopods

(fairy shrimps and tadpole shrimps).
Aquatic insects: Water strider, Giant water bug, *Dytiscus sp.* and *Cybister sp*. Fishes - Catfishes, Crustaceans - Crabs, Prawns.

Unit-IV: Impact on fresh water Habitats [09 Hours]

Impact on Freshwater Habitats: Drivers of freshwater biodiversity loss: Hydrological alteration (dams), pollution, habitat degradation, species over exploitation, urbanization, and climate change. Exotic species invasion in freshwater: biodiversity loss and biotic homogenization. Cultural Eutrophication: causes and consequences.
Conservation measures of Freshwater: Need and importance of conservation. Legislative measures: Ramsar convention, Ramsar sites in India. Inter linking of Indian rivers: Need and associated challenges. National Water Policy.

ESSENTIAL/ RECOMMENDED READINGS:

1. Mellanby, H (1975).Animal life in freshwater, 6th Edn. Chapman-Hall.
2. Welch, P. S. (1935). Limnology.
3. Hutchinson, G. E., & Edmondson, Y. H. (1957). Treatise on limnology. Wiley.
4. Laws, E. A. (2000). Aquatic pollution: an introductory text. John Wiley & Sons.
5. Macan, T. T., & Worthington, E. B. (1951). Life in lakes and rivers.
6. Bal D. V., & Rao K. V. (1984). Marine fisheries. Tata Mc Graw Hill.

MAJOR ELECTIVE COURSE (ZO-ME-519P):
Lab Exercise in Fresh Water Zoology (Practical Elective-I)

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-ME-519P - Lab Exercise in Fresh Water Zoology	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Identify commercially important freshwater fish.
- Illustrate the bio-indicators of pollution in freshwater.
- Acquire knowledge to analyze zooplanktons from local freshwater bodies.
- Understand the culture of Paramecium and Daphnia.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Evaluate the bio-indicators of pollution in freshwater.
CO2: Identify the aquatic adaptations in common freshwater forms.
CO3: Analyze the Zooplanktons from local freshwater bodies.
CO4: Prepare the culture of Paramecium and Daphnia.
CO5: Estimate the hardness and chloride content in water samples.

PRACTICALS of ZO-ME-519P: (12 Practicals)

1. Estimation of total carbon dioxide and chloride form given water sample. **(Compulsory)**
2. Estimation of phosphates forms given water sample. **(Compulsory)**
3. Estimation of total nitrate from given water sample. **(Compulsory)**
4. Estimation of calcium and total hardness of given water sample. **(Compulsory)**
5. Estimation of total alkalinity of given water sample.
6. Collection, preservation and identification of zooplankton from fresh water habitat. (Prepare permanent slides and Identify up to genus level using taxonomic key).
7. A qualitative and quantitative analysis of zooplankton from a given fresh water sample using Lackey's drop count method/ Sedgwick rafter counting cell.
8. Identification of economically important freshwater crustaceans and fishes.
9. Study of aquatic and semi aquatic adaptations in amphibians and reptiles.
10. Estimation of primary productivity with dark and light bottle method. **(Compulsory)**

11. Study of locomotory and respiratory adaptations in aquatic insects and larvae (Ranatra, Notonecta, Gerris, Bellostoma and Dytiscus).
12. A Compulsory visit to local freshwater body and preparation of report on physicochemical conditions and faunal organisms.

RESEARCH METHODOLOGY COURSE (ZO-RM-520T): Research Methodology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-RM-520T - Research Methodology	4	4	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand concept of research and research problems.
- Know the compile and analyze the data with scientific interpretation.
- Acquire skill to writing a research paper using online and offline tools for literature search.
- Understand the application of research and research ethics.
- Understand the data of various research methodologies required for project completion and dissertation

COURSE OUTCOMES:

After completion of this course will be able to:

CO1: Describe the research foundation, problem solving methods and designing the research problem.

CO2: Discuss the data collection and sampling methods along with qualitative and quantitative research.

CO3: Compile and analyze the data with scientific interpretation and writing a research paper using online and offline tools for literature search.

CO4: Explain the process of reporting and thesis writing with proper reasoning.

CO5: Compile the data of various research methodologies required for project completion and dissertation.

SYLLABUS of ZO-RM-520T [60 Hours]

Unit-I: Foundation and Problem Identification [16 Hours]

A) Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific methods, understanding the language of research, concept, construct, definition, variables. Research Process.

B) Problem Identification & Formulation: Definition and formulating the research problem, necessity of defining the problem, importance of literature review in defining a problem, research question/investigation question, measurement issues. Hypothesis: Qualities of a good hypothesis.

Generalization and Interpretation. Statistical hypothesis testing: logic & importance, null hypothesis & alternative hypothesis.

Unit-II: Data Collection & Sampling, Data Analysis [16 Hours]

Data Collection & Sampling: execution of the research - observation and collection of data - methods of data collection, concepts of statistical population, sample, sampling frame, sampling error, sample size, non-response. Characteristics of a good sample. Probability sample –simple random sampling, systematic sampling, convenience sampling, stratified random sampling & multi-stage sampling. Determining size of the sample – practical considerations in sampling and sample size.

Qualitative and Quantitative Research: Qualitative research, Quantitative research, causality, generalization, replication. Merging the two approaches. Concept of measurement -what is measured? Problems in measurement in research - Validity and Reliability. Levels of measurement - Nominal, Ordinal, Interval, Ratio.

Data Analysis: Data preparation and presentation (frequency tables, bar charts, pie charts, histograms, etc.) - Univariate analysis, Bivariate analysis - Cross tabulations and testing hypothesis of association including Chi-square test, correlation and regression analysis.

Unit-III: Interpretation of Data and Writing, Uses of Tools [14Hours]

Interpretation of Data and Paper Writing: Layout of a research paper, when and where to publish? Journals in Life-Sciences, Impact factor of journals indexing: Scopus, Web of Science etc. Ethical issues related to publishing, plagiarism and self-plagiarism.

Use of Literature: Research articles, reviews, encyclopedias, handbooks, and biological databases.

Use of Tools / Techniques for Research: Methods to search required information effectively, reference management software like Zotero/ Mendeley /Endnote, Software for paper formatting like LaTeX /MS Office, software for detection of plagiarism.

Unit-IV: Reporting, Application, Reasoning and Mental Ability [14 Hours]

Reporting and Thesis Writing: Structure and components of scientific reports, types of report, technical report and thesis, different steps in the preparation, layout, structure and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Oral presentation, planning, preparation, practice, making presentation, use of visual aids, importance of effective communications.

Application of Results and Ethics- Environmental impacts, ethical issues, ethical committee, commercialization. Copy right, royalty, intellectual property rights and patents law, trade related aspects of intellectual property rights, reproduction of published material, citation and acknowledgement, reproducibility and accountability.

Reasoning and Mental Ability: Analogy, classification, series, coding-decoding, direction sense. Logical reasoning, inserting the missing character, number, ranking and time sequence test, eligibility test, number and symbol ordering, comprehension questions, statement and assumptions, statement and conclusions, statement and action.

Different funding agencies, Plagiarism software, AI Tools, Equator Network.

ESSENTIAL/ RECOMMENDED READINGS:

1. Research Methodology-C R Kothari.
2. Research Methodology: An Introduction-Stuart Melville and Wayne.
3. Practical Research Methodology-Catherine Dawson.
4. Research Methods for Science Michael P Marder.
5. Research Methodology: Principle, Methods and Practices-Joshua O. Miluwi and Hina Rashid.
6. Research Methodology: A Step by Step Guide for beginners- Ranjeet Kumar.
7. How to Write and publish a Research Paper- Seventh Edition-Robert Day and Barbara Gastle.

Syllabus for M. Sc. I ZOOLOGY

Semester II

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-521T): Molecular Biology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-521T - Molecular Biology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand the DNA structure & types, topology, physical properties, chromatin structure and organization.
- Understand genome organization, DNA and protein sequencing with their application.
- To understand the DNA damage and repair and also illustrate the process of DNA replication, transcription, translation.

COURSE OUTCOMES:

After completion of this course will be able to:

CO1: Discuss chromatin structure and how it can be modified to affects gene expression.

CO2: Explain the mechanism of DNA replication and repair, RNA synthesis and processing, and protein synthesis.

CO3: Discuss the structure and function of protein including the role of individual amino acid in protein folding.

SYLLABUS of ZO-MJ-521T [30 Hours]

Unit-I: DNA Structure and Topology, Properties [08 Hours]

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. Physical properties of DNA: Tm, Hypo and Hyper Chronicity, Solubility, Muta-rotation and Buoyancy. Genome organization: C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence and their importance Cot 1⁄2 and, kinetic and sequence complicity, satellite DNA.

Unit-II: Replication [07 Hours]

DNA Replication: DNA replication in *E. coli*, Origin of replication, types of *E. coli* 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 phages. Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication.

Unit-III: Transcription [07 Hours]

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, Ribo-nucleo-proteins.

Unit-IV: Electronic Spectroscopy of molecules [08 Hours]

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.

Mobile DNA elements: Transposable elements in bacteria, IS elements, composite transposons, explicative, non-explicative transposons, Mu transposition. SINES and LINES. Retro viruses and retro transposons.

ESSENTIAL/ RECOMMENDED READINGS:

1. Molecular Biology of the gene, 7th edition, James D Watson, Pearson publication. (2013).
2. Gene XII, Benjamin Lewin, 12thedition, Jones and Barlett Publishers. (2018).
3. Molecular Biology of the Cell, 7th edition,Bruce Alberts, Rebecca Heald, Alexander D. Johnson, David Morgan, Martin C. Raff, Garland Science, Taylor and Francis Group, (2015).
4. Molecular Cell biology, 6th edition, Lodish Berk, Matsudaira, Kaiser, Krleger pub.,By W. H. Freeman & Company, New York.(2007).

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-522T):
Comparative Endocrinology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-522T - Comparative Endocrinology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Discuss the chemical signals & bio regulation of endocrine gland in vertebrates.
- Explain the synthesis, secretion, metabolism & mechanism of action of vertebrate hormone.
- Describe the hypothalamus - pituitary system.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Justify the comparative aspects of hormones and their physiological functions / role in vertebrates.

CO2: Describe the adrenal glands of mammalian and non - mammalian vertebrates.

CO3: Explain the hormonal control of calcium and phosphate homeostasis.

CO4: Discuss the comparative endocrinology of feeding, digestion and metabolism in vertebrates.

SYLLABUS of ZO-MJ-522T: [30 Hours]

Unit-I: Chemical signals and Bio-regulation in vertebrate [07 Hours]

Chemical signals and bio regulation in vertebrates: An overview and methods used to study bio regulation Synthesis & secretion, Metabolism and mechanism of action of vertebrate hormones.

Unit-II: Hypothalamus [07 Hours]

Hypothalamus - Pituitary system: structural organization and comparative aspects of hypothalamus - Pituitary system in vertebrates; hormonal secretions and biological functions. Hypothalamus– Pituitary - Thyroid axis of vertebrates: comparative aspects; hormones and their physiological functions.

Unit-III: Adrenal glands of mammalian and non-mammalian vertebrates. [08 Hours]

Adrenal glands of mammalian and non-mammalian vertebrates: structural organization, comparative aspects; hormonal secretions and physiological functions. Hormonal control of calcium and phosphate homeostasis.

Unit-IV: Comparative Endocrinology [08 Hours]

Comparative endocrinology of feeding, digestion and metabolism in vertebrates; gastro-intestinal and pancreatic hormones and their role in digestion and metabolism.

ESSENTIAL/ RECOMMENDED READINGS:

1. Comparative Vertebrate Endocrinology by P. J. Bently, Cambridge Univ. Press. (1998).
2. General and Comparative Endocrinology by E. J. W. Barrington, Oxford Clarendan Press. (1975).
3. Text Book of Comparative Endocrinology by Gorbman A. and Bern H.A., John Harley and Sous, New York (2017).
4. Essential of Endocrinology, 4thed., Wiely. Brook, C.G.D. and Marshall, N.J. (2001).
5. Text Book of Endocrinology, 10thedition, Larson Williams., W.B. Saunders Company, Philadelphia. (2002).

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-523T):
Comparative Animal Physiology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-523T - Comparative Animal Physiology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand the concepts of human physiology, its importance, functions of organs and organ systems.
- Know the structure of skeletal muscles and mechanism of muscular contraction. Articulate the conduction of impulses through the neurons and ultra- mechanism of osmoregulation in human body.
- Illustrate the role of kidney in regulation of acid-base balance along with other function.
- Understand the role of digestive enzymes along with meta-genome of gut and regulation of homeostasis through various mechanisms.
- To know about physiological aspects related to digestive, respiratory, circulatory, excretory systems, reproductive and neuro-muscular systems.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Describe the concepts of human physiology, its importance, functions of organs and organ systems.

CO2: Discuss the structure of skeletal muscles and mechanism of muscular contraction. Articulate the conduction of impulses through the neurons and ultra- mechanism of osmoregulation in human body.

CO3: Apply the knowledge of physiology to interpret effect of exercise on cardiovascular activities. Generalize the role of kidney in regulation of acid base balance along with other functions.

CO4: Explain the physiology of human reproductive system and analyze the O2 dissociation curve and its physiological and ecological importance.

SYLLABUS of ZO-MJ-523T: [30 hours]

Unit-I: Digestion and Respiration **[07 Hours]**

Digestion: Peristalsis, digestion and its regulation, nutrient absorption, co-relation of digestive enzymes with food, BMR.
Respiration: Respiratory Surfaces- ventilation associated with pulmonary respiration, tidal and vital capacities, oxygen transport, O2 dissociation curves-physiological and ecological significance, CO2 transport, neural and chemical regulation of respiration.

Unit-II: Muscles and Excretion **[08 Hours]**

Muscle: Types of muscles, ultra-structure of skeletal muscle fibers, Biochemistry of contractile proteins, theory of muscle contraction, chemical basis of contraction, Fatigue.
Excretion: Nitrogenous waste products: ammonia, urea and uric acid their formation and excretion, role of kidney in excretion, Renal regulation of acid-base balance, Micturition.

Unit-III: Circulation **[08 Hours]**

Circulation: Systems of circulation, myogenic and neurogenic heart, Pumping activity of heart, action potential pace maker, cardiac cycle, electrical changes, neural and chemical regulation of heart beat, cardiac output. Blood corpuscles, haemopoiesis and formed elements, plasma function. ECG - its principle and significance.

Unit-IV: Reproduction **[07 Hours]**

Reproduction: Physiology of reproductive cycle and its hormonal regulation. Biochemical composition of semen, sperm capacitation and decapacitation - molecular mechanism and significance. Reproductive glands: Testes; Prostate gland and Ovary.

ESSENTIAL/RECOMMENDED READINGS:

1. General and Comparative physiology, Hoar W. S., Prentice Hall, India, New Delhi
2. Physiology of Sport and Exercise, Kenney WL, Wilmore J and Costill D, Amazon, UK.
3. Animal Physiology, Schmidt-Nielsen, Adaptation and Environment. Cambridge.
4. Principles of Anatomy and Physiology, G. J. Tortora
5. Textbook of Physiology and Biochemistry, Bell and Davidson
6. Principles of Physiology and Biochemistry, Holurn

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-524T): Biochemical Techniques

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-524T - Biochemical Techniques	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Illustrate the principle of light, fluorescence, scanning, transmission electron microscope.
- Understand the principle and differences between various types of chromatography techniques.
- Know about agarose and polyacrylamide gel electrophoresis.
- Understand the principle of centrifugation, various types of Centrifugations, rotors and its applications.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Understand the handling of electrophoresis, centrifuge, spectrophotometer and chromatography.

CO2: Get knowledge about Microscopy, its Principle, working and applications.

CO3: Know about the Biophysical techniques.

CO4: Can be separate biomolecules like DNA, RNA, Protein, etc.

SYLLABUS of ZO-MJ-524T [30 Hours]

Unit-I: Chromatography and Electrophoresis [07 Hours]

Chromatography: Principle and applications, Ion-Exchange Chromatography, Affinity chromatography. Molecular exclusion chromatography, Thin layer chromatography, HPLC.

Electrophoresis: Principle of Electrophoresis, Electrophoresis unit, different supports used for electrophoresis and its functions. PAGE, 2D electrophoresis, Capillary electrophoresis, Agarose gel electrophoresis.

Unit-II: Centrifugation and spectroscopy [08 Hours]

Centrifugation: Principle, g and RPM concept, Types of rotors, Preparative and analytical centrifugations. Density gradient centrifugation. Applications of centrifugation.

Spectroscopy: Principle and components of spectrophotometer, concepts of light & electromagnetic spectrum. Ultraviolet and Visible spectrophotometer, Atomic absorption spectroscopy.

Unit-III: Microscopy [08 Hours]

Microscopy**:** Principle, working and applications: Inverted and upright microscope, Phase contrast microscope, Fluorescence microscope, Confocal microscope, Transmission and scanning microscope.

Unit-IV: DNA and Protein Sequencing method, Biophysical techniques [07 Hours]

DNA sequencing method: Maxam - Gilbert Sequencing, Chain termination method, Dye terminator sequencing. Next Generation Sequencing, Protein sequencing method: N - terminal sequencing, C – terminal sequencing.

Biophysical Techniques: NMR. Surface Plasma Resonance. Structure determination using X-ray diffraction.

ESSENTIAL/ RECOMMENDED READINGS:

1. Electrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein Separations, 4thEdition, Dr. Reiner Wester meier. (2004).
2. Principles and Techniques of Biochemistry and Molecular Biology, 6thedition, Keith Wilson and John Walker, Publisher Cambridge University Press. (2008).
3. Light Microscopy in Biology: A Practical Approach, 2ndedition, Alan J. Lacey, Publisher Oxford University Press (1999).
4. Electron Microscopy: Principles and Techniques for Biologists, Lonnie D. Russell, Publisher Jones & Bartlett (1992).

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-525T):
Integrated Pest Management

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-525T - Integrated Pest Management	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand basics of IPM, principles, tools, ethics & significances.
- Detect and diagnose different insect pests, their diseases & calculate economic injury level, economic threshold level.
- Understand pesticides, fungicides, herbicides, bio-herbicides and different methods used for pest control.
- Know different Entomopathogenic organisms.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Apply advanced technology for pest control.

CO2: Learn about methods of detection and diagnosis of insect pest and diseases.

CO3: Get knowledge about Pest Management Tactics.

SYLLABUS of ZO-MJ-525T: [30 Hours]

Unit-I: Introduction [07 Hours]

Introduction**:** Definition, Principles and tools, Significance, Ethics in IPM, Social and political constraints, Ecological applications to IPM.

Unit-II: Methods of detection and diagnosis of insect pest and diseases [08 Hours]

Methods of detection and diagnosis of insect pest and diseases:

Damage caused by insect pests having different types of mouth parts and their damage symptoms, Plant and Pest diagnosis and Identification through Distance Diagnostic and Identification System (DDIS), Io T based pest detection with its benefits -Low power cameras & sensors, High power thermal sensors, Florescence image sensing, Acoustic sensors, Gas sensors. Calculation and dynamics of economic injury level. Importance of economic threshold level.

Unit-III: Pest management Tactics, Control [08 Hours]

Pest Management Tactics: Introduction to Pesticides, Fungicides and Herbicides. Regulatory Control-Quarantine, Eradication, Control districts, Crop-free periods, Certification of seed and planting stock.

Cultural control-Sanitation, Tillage, Crop rotation, Cropping systems.

Chemical Control-Ecological considerations- Pesticide classification, Pesticide resistance, Chemical modes of action, Pesticide Use-Health and environmental concerns, Safety protocols. Biological Control-Ecological considerations, biological control of insects, biological control of plant disease, biological control of weeds, role of Pheromones in Insect Pest Management. Genetic manipulation of crop (plant resistance) -Sources of genetic variation, overview of plant resistance to insects, Inheritance and expression of plant resistance, deployment of resistance genes. Genetic manipulation of pest population -Sterile insect release, Delayed sterility, Genetic displacement.

Unit-IV: Entomopathogenic Viruses and Bacteria for Insect pest control: [07 Hours]

Entomopathogenic Viruses and Bacteria for Insect pest control: Entomopathogenic Nematodes in Integrated pest management. Bio herbicide approach to weed control by using plant pathogens. Role of information and communication technology in integrated pest management. Application of Remote Sensing in integrated pest management.

ESSENTIAL/RECOMMENDED READINGS:

1. Integrated Pest Management: Principles and Practices, D. P. Abrol, Uma Shankar CABI (2012).
2. Natural Enemies Handbook, Mary Louise Flint, Steve H. Dreistadt, UC Division of Agriculture and Natural Sciences. (1998).
3. Insect Pest Management: Ecological Concepts, T. V. Sathe, Jyoti M. Oulkar, Daya Publishing House. (2010).
4. Integrated Pest Management, William D. Hutchison, Rafael E. Cancelado, Edward B. Radcliffe, and Cambridge University Press. (2009).

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-526P):
Lab. Exercise in Molecular Biology and Biochemical Techniques

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-526P - Lab. Exercise in Molecular Biology and Biochemical Techniques	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand various components of light, fluorescence, scanning and transmission electron microscope.
- Perform density gradient centrifugation.
- Perform thin layer chromatography.
- Perform paper chromatography.
- Perform sterilization of lab equipment.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Isolation and quantification of prokaryotic and eukaryotic nucleic acids.
CO2: Understand how to extract and quantify DNA from samples.
CO3: To know how to extract and quantify RNA from samples.
CO4: Understand how to extract and quantify proteins from samples.

SYLLABUS of ZO-MJ-526P (15 Practical)

1. Lab Safety Techniques and sterilization.
2. Isolation of bacterial DNA. **(Compulsory)**
3. Estimation of isolated bacterial DNA by UV spectrophotometry. **(Compulsory)**
4. Separation of isolated bacterial DNA by agarose gel electrophoresis. **(Compulsory)**
5. Estimation of isolated bacterial DNA by diphenylamine method.
6. Isolation of Liver DNA.
7. Estimation of isolated RNA by Orcinol method.
8. Demonstration of DNA amplification by PCR.
9. Principles of Electrophoresis, separation of proteins using Gel Electrophoresis. **(Compulsory)**

10. To study the effect of different solvents for a given dye using thin layer chromatography. **(Compulsory)**
11. Study of principle and uses of different microscopes. Components of light microscopy, upright & inverted microscopes, episcopic & diascopic microscopic alignment. Different types of lenses, numerical apertures. **(Compulsory)**
12. Estimation of protein by Lowry et. al., method. **(Compulsory)**
13. Separation of sugars by paper chromatography.
14. Characterization of any Bio/ nonmaterial by using suitable techniques: UV-Visible spectroscopy/ XRD/ SEM/TEM/ EDS / FT-IR Studies.
15. Visit to any nearby Central Instrumentation Facility Centre and to study the principle and working of Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Fluorescence Microscope etc. and Report writing.

DISCIPLINE SPECIFIC CORE COURSE (ZO-MJ-527P):
Lab. Exercise in Comp. Animal Physiology and Endocrinology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-MJ-527P - Lab. Exercise in Comp. Animal Physiology and Endocrinology	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Perform estimation of amylase from human saliva.
- Demonstrate oxygen consumption in relation to body size.
- Demonstrate effect of different physiological conditions on red blood cells.
- Demonstrate pancreatectomy and thyroidectomy in experimental animals.
- Demonstrate effect of epinephrine on blood sugar level and liver glycogen.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Perform detection of nitrogenous waste products in different animal groups.

CO2: Perform estimation of sugar in rat / crab / human blood.

CO3: Demonstrate bleeding & clotting time of human blood.

CO4: Understand structural and functional difference between invertebrate and vertebrate Neurosecretory and endocrine organs.

PRACTICALS of ZO-MJ-527P (15 Practical)

1. Study of nitrogenous waste products of animals from different habitats. **(Compulsory)**
2. Study of RBCs in different vertebrates and in different physiological conditions.
3. Study of relation of Body size and oxygen consumption in aquatic animals (crab / fish). **(Compulsory)**
4. Estimation of sugar in crab / rat / human blood. **(Compulsory)**
5. Measurement of lung capacity.
6. Determination of the heart beat in the crab & effect of temperature.
7. Measurement of blood pressure by using Sphygmomanometer.
8. Study of skeletal muscles from suitable material. **(Compulsory)**
9. Study of histological slides of Endocrine glands of vertebrates -Pituitary, Thyroid, Parathyroid, Thymus, Adrenal. **(Compulsory)**

10. Study of histological slides of Endocrine glands of vertebrates -Pancreas, Ovary, Testis, and Uterus. **(Compulsory)**
11. Blood sugar regulation in the crab-Role of eye stalk.
12. Introduction of alloxan diabetes in the mouse/ rat. **(Compulsory)**
13. Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat.
14. Gonadactomy/ Pancreatectomy/ Thyroidectomy in the mouse/ rat.
15. Effect of thyroid hormone on amphibian metamorphosis.

MAJOR ELECTIVE COURSE (ZO-ME-528AT):
Medical Parasitology

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-ME-528AT - Medical Parasitology	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand the concept of parasitism and host - parasite interactions.
- Specify various aspects of parasites of medical importance as geographical distribution and epidemiologic principles and describe the morphology and life cycle.
- Understand about reduced sensitivity to Anti - malarial drugs.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Recognize the scientific basis of the conventional and up to date diagnostic procedures needed to carry out accurate diagnosis of common parasitic diseases with emphasis on their prioritization in management plans.

CO2: Describe the various successful adaptations evolved by parasites.

CO3: Identify common arthropods act as vectors and their medical importance.

SYLLABUS OF ZO-ME-528AT: [30 Hours]

Unit-I: General Introduction Parasitology [07Hours]

General Introduction: Parasitology-Parasite, host, basic concept of parasitism, parasitoids, evolution of parasitism, types of parasites and hosts, types of vectors, parasitic characteristics, parasitic transmission, alteration of host behavior by parasites and social parasitism.

Unit-II: Immune Response Mechanism and Adaptation to Parasitism: [07Hours]

Immune Response Mechanism and Adaptation to Parasitism: Immune response to parasitic infection, immunemodulation by parasites, polymorphism in the immune system, coevolution of host-parasite interactions, morphological adaptations, life cycle adaptations, immunological adaptations, biochemical adaptations.

Unit-III: Biology of Parasites: [08 Hours]

Biology of Parasites: Geographical distribution, morphology, life cycle, mode of infection, clinical

features, disease management, treatment and prophylaxis of parasites:
Protozoa-*Trypanosoma* sp.,*Plasmodium* sp.,*Entamoeba histolytica*, *Leshmania*sp.;Trematodes-*Fasciolopsis buski*, *Paragonimus westermani*, *Schistosoma mansoni*; Cestodes-*Hymenolepis nana*, *Taenia solium*, *Echinococcus granulosus*, *Diphyllobothrium latum;* Nematodes-*Trichuristri chura*, *Strongyloidesster coralis*, *Dracunculus medinensis*, *Wuchereria bancrofti.*
Arthropods as Parasitic vectors: Significance of arthropods as vectors, general features and control measures of biting Dipterans -Mosquitoes, Black flies, Sand flies, Tsetse flies, Tabanid flies, Fleas, Lice, Ticks, Mites.

Unit-IV: Zoonotic Diseases [08 Hours]

Zoonotic Diseases: Introduction, Rabies, Toxoplasmasis, Brucellosis, Anthrax symptoms, preventive and control measures. Diagnostic Laboratory Methods of Parasitic infections: Introduction, Diagnostic methods: Examination of Stool, Blood, Sputum, Tissue Biopsy, Uro-genital Specimen Culture Methods, Xeno diagnosis, Immunological diagnosis and molecular methods.
Control Measures and Vaccination Development: Chemical control-Drugs against parasites, Drug resistance, Status of Drug Resistance in India. Anti-malarial drug resistance: Chloroquine; Sulphadoxine- Pyrimethamine and Artemisinin. Mechanism of drug resistance in *Leshmania*. Biological and Genetic control of parasites, Vaccine development strategies against parasitic diseases.

ESSENTIAL/RECOMMENDED READINGS:

1. Introduction to Parasitology, 10thed., Chandler, A.C. & Read. C. P., John Wiley & Sons Inc. (1961).
2. General Parasitology, 2nded., Cheng, T. C. Academic Press, Inc. Orlando. U.S.A. (1986).
3. Modern Parasitology. 2nded., Cox, F. E. G., Blackwell Scientific Publications, Lea and Febiger, Philadelphia (1993).
4. Parasitism: The Diversity and Ecology of Animal Parasites, Tim Goater, Timothy M. Goater, Cameron P. and Esch, Gerald W. Cambridge University Press. (2014).
5. Principles of Veterinary Parasitology,1sted., Dennis E. Jacobs, Mark Fox, Lynda M. Gibbons, Carols Hermosilla, John Wiley & Sons. (2016).

MAJOR ELECTIVE COURSE (ZO-ME-528BT): Metabolic Pathways

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-ME-528BT – Metabolic Pathways	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Define basic terminologies of metabolic pathways
- Explain the laws of thermodynamics, concept of free energy and ATP as currency molecule.
- Describe the Concepts and regulation of metabolism
- Discuss the oxidation of fatty acids and its significance
- Illustrate the electron transport chain and oxidative phosphorylation

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Illustrate the reactions, energetic and regulation of glycolsis, glycogen biosynthesis, TCA cycle, Purine and Pyrimidine metabolism.

CO2: Write the general reactions of various metabolic pathways.

CO3: Justify the role of enzymes in metabolism.

SYLLABUS of ZO-ME-528BT: [30 Hours]

Unit-I: Basic law of thermodynamics and Concept of metabolism [07 Hours]

Basic law of thermodynamics-internal energy, enthalpy, entropy, concept of free energy, redox potentials, high energy compounds, structure and function of ATP. Concepts of metabolism, Metabolic Pathways-Catabolic and anabolic, regulation of metabolic pathways.

Unit-II: Carbohydrate Metabolism and ETC [08 Hours]

Carbohydrate Metabolism- Steps of Glycolysis (EMP Pathway). PFK, Regulation of Glycolysis, Glycogensis, Glycogenolysis and Glyconeogenesis, Inborn errors of metabolism- Von- Gerkes disease, Tarui's disease, Galactosemia, Maple syrup Electron transport chain and oxidative phosphorylation.

Unit-III: Citric acid cycle [08 Hours]

Citric acid cycle: Detailed study, energetic, regulation and significance, Role of PDH.

Oxidative degradation of amino acids: transamination, oxidative deamination.

Unit-IV: Biosynthesis of Purine and Pyrimidine nucleotides. [07 Hours]

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.

ESSENTIAL/ RECOMMENDED READINGS:

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., (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.

MAJOR ELECTIVE COURSE (ZO-ME-529P):
Metabolic Pathways (Practical Elective-II)

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-ME-529P - Metabolic Pathways	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Perform estimation of Starch.
- Finding absorption spectrum of Haemoglobin, BSA, Tyrosine.
- Determination of saponification value of a fat.
- Separate amino acids by TLC method.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Perform detection of Study α-Amylase Activity in Germinating Seeds.
CO2: Perform determination of saponification value of a fat.
CO3: Analyze the effect of pH and temperature on enzyme activity.
CO4: Understand human diseases caused due to errors in metabolic pathways.

PRACTICALS of ZO-ME-529P(13 Practicals):

1. Estimation of Starch. **(Compulsory)**
2. Separation amino acids by paper chromatography
3. Estimation of uric acid in wall Lizard excreta/ Human blood any other suitable material. **(Compulsory)**
4. To find absorption spectrum of Hemoglobin, BSA, Tyrosine.
5 . Estimation of Protein by Lowry et al Method. **(Compulsory)**
6. Estimation of Sugar by DNSA method.
7. Separation of amino acids by TLC **(Compulsory)**
8. Estimation of free amino acids by Ninhydrin method. **(Compulsory)**
9. Estimation of cholesterol.
10. Study α-Amylase Activity in Germinating Seeds
11. Determination of saponification value of a fat.
12. Study the effect of pH and temperature on enzyme activity.

13. Study of human diseases caused due to errors in metabolic pathways with the help of pictures/charts/models/laboratory reports.

MAJOR ELECTIVE COURSE (ZO-OJT-530P):
On Job Training

Course Code &Title	Credits	Credit Distribution of the Course	
		Lecture	Practical
ZO-OJT-530P - On Job Training	4	--	4

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Develop problem-solving skills.
- Demonstrate knowledge of research processes.
- Develop hands-on experience in a specific field of zoology.
- Perform literature review using print and online databases.

COURSE OUTCOMES:

After completion of this course student will able to:

CO1: Select and define appropriate research problem and parameters to prepare a project report.
CO2: Identify, explain, compare, and prepare the key elements of a research proposal.
CO3: Compare and contrast quantitative and qualitative research paradigms.
CO4: Use sampling methods, measurement scales and instruments, and appropriate uses of each.

SYLLABUS of ZO-OJT-530P: [60 Hour]

Unit 1- On Job Training for Field Project: [16 Hours]

On job training could be organized by respective P. G. Department in College, Government organizations like ZSI, NCL, Agricultural Universities / Institutes etc. or any other local Industrial organization / Industry related to Life Sciences / Zoology related to research topic, Authorized pathological laboratories, Wild life Sanctuary, National Park, Fishery station etc. (Duration one Week)

Unit 2- On Job Training for Field Project should cover the following aspects: [16 Hours]

a) Preparation of research design / topic with consideration of aim and objectives of research so as to satisfy local or social need of area.
b) Awareness regarding handling experimental equipment, Chemicals, laboratory and personal safety parameters.
c) Selection of model / experimental organism.

d) Field survey of experimental organism, life cycle, animal behavior, availability of experimental animals, Study of habitat w.r.t. biodiversity studies, methods of counting population Density.
e) Study of habitat w. r. t. various physicochemical parameters.
f) Methods of animal collection by using different aids like nets, Traps etc.
g) Study of biological techniques including cell fractionation, spectrophotometry, PCR, animal preservation, tissue fixation, Sectioning, staining, morphometry etc.
h) Computer applications, Bioinformatics and Statistical Applications.
i) Permission of ethical committee of State Government for the Use of experimental animals (if necessary).
j) Submission of On Job Training Report and Certificate.

Unit III- Experimental Research Work: [16 Hours]

a) Title of topic: Precise and accurate to express or indicate the Entire theme of research work.
b) Introduction: To focus the scope and importance of research Topic.
c) Review of Literature: To support the research work and to Predict the results.
d) Submission of compulsory review of at least two research Articles related to the topic.
e) Material and methodology of research experimentation.
f) Observations, data collection of study parameters
g) Analysis of data and application of suitable statistical tests.
h) Results and discussion.
i) Conclusion.
j) References / Bibliography.

Unit IV- Project writing and Compilation of data, Submission of Dissertation: [12 Hours]

Project dissertation should cover all points, including - Title of topic, Introduction, Review of Literature, Material and methods, Observation Table, Results and discussion, References / Bibliography. (Project dissertation should not exceed 100 pages).