SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE
(Autonomous)
[An Autonomous College Affiliated to Periyar University, Salem, Tamil Nadu]
[Accredited by NAAC with 'A' Grade with CGPA of 3.27]
[Recognized 2(f) & 12(B) Status under UGC Act of 1956]
Katteri – 636 902, Uthangarai (Tk), Krishnagiri (Dt)
Tamil Nadu, India
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DEGREE OF MASTER OF SCIENCE IN ZOOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS AND SYLLABUS FOR

M.Sc. ZOOLOGY PROGRAMME
(SEMESTER PATTERN)

(For Students Admitted in the College from the Academic Year 2021-2022 Onwards)

Programme Outcomes (POs)

PO1	Students gain knowledge and skill in the fundamentals of animal sciences, Understands the complex interactions among various living organisms.
PO2	Analyse complex interactions among the various animals of different phyla, Their distribution and their relationship with the environment.
PO3	Apply the knowledge of internal structure of cell, its functions in control of Various metabolic functions of organisms.
PO4	Understands the complex evolutionary processes and behavior of animals.
PO5	Apply the knowledge and understanding of Zoology to one's own life and work.

Programme Specific Outcomes (PSOs)

PSO1	Understand the nature and basic concepts of cell biology, Genetics, Taxonomy, Physiology, Ecology and Applied Zoology.
PSO2	Perform procedures as per laboratory standards in the areas of Taxonomy, Physiology, Ecology, Cell biology, Genetics, Applied Zoology, Clinical science, tools and techniques of Zoology, Toxicology, Entomology, Nematology Sericulture, Biochemistry, Fish biology, Animal biotechnology, Immunology and Research methodology
PSO3	Analyse the relationships among animals, Plants and Microbes.
PSO4	Understand the applications of biological sciences in Apiculture, Aquaculture, and Medicine.
PSO5	Gains knowledge about research methodologies, effective communication and skills of problem solving methods.

SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE

(Autonomous)

Master of Sciences (M.Sc.) in Zoology

Programme Pattern and Syllabus (CBCS)

(For Students Admitted in the College from the Academic Year 2021-2022 Onwards)

Sl. No.	Nature of the Course	Course Code	Name of the Course	Hours/ Week	Credits	Marks		
						CIA	ESE	Total
SEMESTER I								
1	Core – I	21PZO1C01	Biology of Invertebrates	5	4	25	75	100
2	Core – II	21PZO1C02	Biology of Chordates	5	4	25	75	100
3	Core – III	21PZO1C03	Cell and Molecular Biology	5	4	25	75	100
4	Core – IV	21PZO1C04	Biochemistry	5	4	25	75	100
5	Elective – I	----	From Group-A	4	3	25	75	100
6	Practical- I	21PZO1P01	Lab Course-I (Covering Core I – IV)	4	5	40	60	100
			Library/Seminar	2	-	-	-	-
Total				**30**	**24**	**165**	**435**	**600**
SEMESTER II								
7	Core – V	21PZO2C05	Animal Physiology and Endocrinology	6	4	25	75	100
8	Core – VI	21PZO2C06	Molecular Genetics	6	4	25	75	100
9	EDC	---	Extra Disciplinary Course (EDC) (Other than Botany Major Subject)	4	4	25	75	100
10	Elective – II	----	From Group-B	5	3	25	75	100
11	Common Course	21P2HR01	Human Rights	2	2	25	75	100
12	Practical-II	21PZO2P02	Lab Course – II (Covering core V–VI)	5	5	40	60	100
			Library/Seminar	2	-	-	-	-
Total				**30**	**22**	**165**	**435**	**600**

SEMESTER III								
13	Core – VII	21PZO3C07	Aquaculture	6	4	25	75	100
14	Core – VIII	21PZO3C08	Immunology	6	4	25	75	100
15	Core – IX	21PZO3C09	Developmental Biology	5	4	25	75	100
16	Core – X	21PZO3C10	Research Methodology	5	4	25	75	100
17	Practical-III	21PZO3P03	Lab Course – III (Covering Core VII–X)	6	5	40	60	100
			Library/Seminar	2	-	-	-	-
Total				**30**	**21**	**140**	**360**	**500**
SEMESTER IV								
18	Core – XI	21PZO4C11	Evolution	5	4	25	75	100
19	Core – XII	21PZO4C12	Environmental Biology	5	4	25	75	100
20	Core – XIII	21PZO4C13	Economic Zoology	5	4	25	75	100
21	Practical-IV	21PZO4P04	Lab Course – IV (Covering Core–	4	5	40	60	100
22	Project	21PZO4PR	Project Work and Viva Voce	11	5	25	75	100
23	Internship Program				1			
Total				**30**	**23**	**140**	**360**	**500**
Cumulative Total				**120**	**90**	**610**	**1590**	**2200**

Elective Courses

Semester	Course Code	Paper Title	Credits
Group – A			
Semester I	21PZO1E01	Applied Entomology	3
	21PZO1E02	Pathology and Clinical Laboratory Techniques	3
	21PZO1E03	Biological Techniques	3
Group – B			
Semester II	21PZO2E04	Cancer and Stem Cell Biology	3
	21PZO2E05	Microbiology	3
	21PZO2E06	Biotechnology	3

SUPPORTIVE PAPERS FOR OTHER PG COURSES

Semester	Course Code	Paper Title	Credits
Semester II	21PZO2EDC01	Wild Life Biology	4
	21PZO2EDC02	Vermitechnology	4

Note

CBCS – Choice Based Credit system,

CIA – Continuous Internal Assessment

ESE – End of Semester Examinations

PROGRAMME SYLLABUS

Program: M.Sc. Zoology				
Core – I	**Course Code:** 21PZO1C01		**Course Title:** Biology of Invertebrates	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	5	75	4	100

Course objectives

1. The students will classify the Invertebrates up to order level.
2. To understand the feeding and Respiratory mechanisms in Invertebrates.
3. To learn the mechanism of chemical coordination and Reproduction in Invertebrates.

UNIT-I

General Classification of invertebrates up to order level.

Locomotion Amoeboid- Flagella and Ciliary movement in protozoa. Locomotion in Annelida and Echinodermata.

UNIT-II

Feeding habits: Nutrition and feeding mechanism in invertebrates-Nutrition in protozoa, Types and mode of feeding -feeding diversity in insects- Filter feeding in Lower metazoans, Crustacean, Mollusca and Echinodermata - functional mechanism. Sponge culture and its importance in industry

Respiration: Respiratory organs – Gills – Gill book – Book lungs – Parapodia – Trachea - Water vascular system with reference to respiration.

UNIT-III

Digestive Systems: Digestive system in invertebrates

Excretion: Excretory organs and excretory products in Invertebrates.

Circulatory system: Circulation in Invertebrates – Open and Closed system.

Receptors: Mechano reception – Chemoreception – Photoreception.

UNIT-IV

Nervous System: Primitive types – Coelenterates - Echinoderms and Hemichordates. Advanced types – Metameric nervous system – Giant nerve fibers – Molluscan nervous system and Learning in Cephalopods. - Sensory Organs: Components of a sensory organs- General sensory organs in crustaceans

UNIT-V

Chemical Co-ordination: Hormones and neurohormones – Endocrine regulation in annelids, insects, and Molluscs – Pheromones and Allelochemicals.

Reproduction: Asexual reproduction in Protozoans and Polychaetes. Unity in the early development of Metazoa – Protostomia and Deuterostomia. Phylogeny of invertebrates.

Reference Books

1. Barnes R. D (1982) Invertebrate Zoology.4th Edition, Holt Saunders International Edition.
2. Barrington E.J.W (1979) Invertebrate Structure and Functions.2nd Edition, ELBS and Nelson.
3. Barrington E.J.W (2012) Invertebrate Structure and Function, (2nd Ed) Affiliated East West Press Pvt. Ltd. New Delhi.
4. Hyman G.H (1955) The Invertebrates, Vol. I to VII, McGraw Hill Book Co., Inc., New York.
5. Kashya P .V (1997) Life of Invertebrates. Vikas Publishing House Pvt. Ltd., New Delhi.
6. Kotpal R.L (2014) Modern Text Book of Zoology – Invertebrates, (2016 Ed) Rastogi Publications – Meerut, New Delhi.
7. Pechenik J.A. (2005) Biology of the Invertebrates Mc Graw Hill, India.
8. Veer Bala Rastogi (2017) Invertebrate Zoology, Rastogi Publications
9. Waterman A .J (1971) Chordate Structure and Function. The Macmillan Company.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Define invertebrates based on their morphology.	K1
CO2	Know the feeding mechanisms of invertebrates.	K2
CO3	Get the knowledge about chemical coordination and reproduction In Invertebrates.	K3

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of Cos with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	M	M
CO3	M	M	M	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – II	**Course Code:** 21PZO1C02		**Course Title:** Biology of Chordates	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	5	75	4	100

Course Objectives

1. To motivate the students to learn the classification of chordates.
2. To facilitate the students to know about the salient features of fishes and Reptiles.
3. To make the students to understand the adaptations in Aves and Mammals.

UNIT-I

Origin of Chordates and classification of Prochordates: Geological time scale - Origin of chordates -Vertebrate relationships and Basic structure.

UNIT-II

Amphioxus – Type study

Pisces: General characters and Outline classification up to orders with suitable examples.

Type study: Shark.

Amphibia: Characters and Classification of Amphibia up to order level. Origin of Amphibia, External characters of Frog and Parental care in Amphibia.

UNIT-III

Reptilia: General characters and outline classification. Morphology of Calotes. Origin and Adaptive radiation in Reptilia – Extinct Reptiles. Identification and study of Poisonous and Non-poisonous snakes of India.

UNIT-IV

Aves: General characters and outline classification

Type study: Pigeon. *Arachaeopteryx* -Significance of *Archaeopteryx*-Migratory Birds.

UNIT-V

Mammalia: General characters and Outline classification. Type study: Rabbit. Importance of Marsupial Mammals. Exoskeleton structures of birds and mammals - Dentition in Mammals - Ruminant stomach in mammals and Echolocation in Bats.

Vertebrate Fossils: *Archaeopteryx* and Mesozoic mammals.

Reference Books

1. A.J. Waterman (1971) Chordate Structure and Function, Collier Macmillan Ltd.
2. Ekambaranatha Ayyar, M. and Ananthakrishnan, T.N. (2003). A Manual of Zoology, Part- II (Chordata). Viswanathan Printers and Publishers, Chennai.
3. F. Harvey Pough, Christine M. Janis, John B. Heiser (2012), Vertebrate Life (9th Edition) Pearson Publisher
4. J. Z. Young, Marion Nixon (1981) The Life of Vertebrates, Oxford University Press.
5. Jordan, E.L. and Verma, P.S. (2013). Chordate Zoology.14th Edition, S. Chand & Company, New Delhi.
6. Kent, G.C. and Carr, R.K. (2001). Comparative Anatomy of the Vertebrates. 9th Edition, McGraw Hill Book Company.
7. Kotpal, R.L. (2015). Modern Textbook of Zoology Vertebrates. 4thEdtion, Rastogi Publications, Meerut, New Delhi
8. Libbie Henrietta Hyman, 1992, Hyman's Comparative Vertebrate Anatomy, University of Chicago Press.
9. Prasad, S.N. and Kashyap, V. (2012). A Textbook of Vertebrate Zoology. 14th Edition, New Age International Pvt., Limited.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Classify chordates based on their morphology.	K2
CO2	Differentiate fishes and amphibians based on the morphology.	K5
CO3	Select the adaptations of birds and mammals for terrestrial life.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of Cos with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	M	M
CO3	M	M	M	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – III	**Course Code:** 21PZO1C03		**Course Title:** Cell and Molecular Biology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	5	75	4	100

Course Objectives

1. To enable the students to gain basic and comprehensive knowledge in the multidisciplinary science of eukaryotic cell biology.
2. To develop in-depth knowledge on molecular basis of cell functions.

UNIT-I

Structure of atoms, molecules, chemical bonds and interactions. Composition, structure and function of carbohydrates, lipids, proteins, nucleic acids and vitamins. Cell organization, Subcellular structures of prokaryotic and eukaryotic cells.

Discovery of Cell: Cell theory- Protoplasm theory - Prokaryotic and Eukaryotic cell differentiation - Cell Cycle and regulations.

Cell division: Mitosis - Meiosis and their significance.

Cytoplasm: Physical and biological properties of cytoplasmic matrix.

Plasma membrane: Chemical composition Structure and functions.

Ribosome and Golgi bodies: Ultrastructure types and functions.

Lysosome: Chemical composition- Polymorphism and Functions.

Endoplasmic reticulum and plastids: Ultrastructure - types and functions.

Mitochondria: Ultrastructure and functions. Micro bodies Peroxisomes and Glyoxisomes

UNIT-II

Nucleus: Ultra-structure of nuclear membrane. Nucleolus- Nucleoplasm and Chromatic fibers. Microtubules, microfilaments – Cilia and Flagella Signal-Types of signaling pathways that control gene activity, Integration of signals and gene controls.

Transduction Pathways: organization signals - Receptors. Ion channel coupled

receptors – Secondary messengers. Amplifiers- Integrators and Signal hypothesis.

UNIT-III

Nucleic Acid: DNA as genetic material (direct and indirect evidences) – Structure and types of DNA and RNA.

Eukaryotic Chromosome: Chromosome structure and organization - C-value paradox DNA – repetitive DNA and Junk DNA.

UNIT-IV

DNA Replication: Semi conservative and rolling circle models - Enzymes involved in replications-DNA damage and repair mechanisms.

Mechanisms RNA splicing in eukaryotes. t-RNA, m-RNA, r-RNA and hn-RNA structures and folding. Conformation of nucleic acids, and Micro-RNA.

UNIT-V

Chromosomal Aberration and Simple Mendelian Traits in Man

Chromosomal Aberration: Introduction – Types of chromosomal abnormalities – Numerical chromosomal abnormalities – Autosomal abnormalities – Sex chromosome abnormalities.

Simple Mendelian Traits in Man: Albinism – Taste Blindness for PTC – Eye Colour – Rh Blood group – Phenylketonuria and Sickle cell Anemia.

Reference Books

1. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2009) Essential Cell Biology. Garland Science, New York.
2. Cooper, GM (2005) The Cell – A Molecular Biological Approaches. ASM Press, Washington.
3. De Robertis E.D.P and De Robertis E.M.F (2001) Cell and Molecular Biology. Lippincott Williams and Wilkins, USA.
4. Gupta P.K (2009) Cell and Molecular Biology. Rastogi Publications, Meerut.
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition,

John Wiley and Sons Ltd. New York.

6. Lewin B (2010) Genes. Oxford University Press, Oxford.
7. Pavlella P. (1998) Introduction to Molecular Biology, McGraw-Hill Companies Inc., New York.
8. Roy SC and De K.K (2010) Cell Biology, New Central Book Agency, Calcutta.
9. Thorpe NO (2000) Cell Biology, John Wiley and Sons, New York.
10. Turner P.C McLennan A.G Bates A.D and White M.R.H (2007) Instant Notes Molecular Biology. Viva Books Pvt. Ltd., New Delhi.
11. Walker J.M and Gingold E.B (2010) Molecular Biology and Biotechnology. Panima University Press, Oxford Publishing Co., New Delhi.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe and discuss the properties and biological significance of the major classes of molecules found in living organisms and the relationship between molecular structure and biological function.	K1
CO2	Cell and molecular biology is platform for the emergency of different fields like genetic engineering, cell culture, biotechnology and molecular biology.	K2
CO3	Explain the structure of membranes and intracellular compartments and relate these to function.	K4
CO4	Describe the processes that control eukaryotic cell cycle and cell death.	K5
CO5	Link the rapid advances in cell and molecular biology to a better understanding of diseases, including cancer	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	M	S	M	M	M
CO3	S	M	S	S	S
CO4	M	S	M	S	M
CO5	S	M	S	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – IV	**Course Code:** 21PZO1C04		**Course Title:** Biochemistry	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	5	75	4	100

Course Objectives

1. To enable the students to learn the biological phenomena at the molecular level.
2. To provide a basic and advanced understanding of the principles of Biochemistry.
3. To acquire knowledge on the fundamental chemical principles that governs complex biological systems.

UNIT-I

Bio macro molecules and their physiological significance

Chemical Composition of living matter. Biological importance of water. Classification, structure and function of carbohydrates- Lipids and Amino acids. -Nucleic acids and Vitamins. Diabetes and their biomedical significance of carbohydrates.

UNIT-II

Metabolism of biomolecules

Metabolism of Carbohydrates: Glycolysis- Pyruvate oxidation-Citric acid cycle- Glycogen metabolism- Gluconeogenesis and Pentose phosphate pathway.

Metabolism of Protein: Deamination- Transamination and Decarboxylation. Urea cycle.

Lipid Metabolism: Bioenergetics oxidation and Reduction reactions **β** Oxidation

UNIT-III

Enzymology

Enzymes: Definition- Classification of enzymes and Enzyme kinetics - Enzyme regulation- Principle and Mechanism of enzyme catalysis - Isozymes.

Types of Inhibition: Feedback and allosteric – Competitive - Uncompetitive and Non-competitive.

UNIT-IV

Porphyrins: Hemoglobin synthesis and Sickle cell anemia- Nucleoside and Nucleotide. **Nucleic acids:** Free nucleotides – Structure - Properties and Functions of RNA and DNA. Synthesis and Degradation of purine and Pyrimidine (De novo and salvage pathways). **Syndromes associated with nucleic acid metabolism**: Aicardi-Goutières syndrome (AGS), Lesch- Nyhan syndrome and GOUT Disease.

UNIT-V

Signal transduction: Hormones and their receptors - Steroid hormone receptor and Gene action. Peptide hormone receptor (cell surface receptors) - signaling through G-protein coupled receptors - Signal transduction pathways- Camp- cGMP - phosphatidyl inositol and Calcium as second messengers and Regulation of signaling pathways.

Reference Books

1. Ambika Shanmugam (2012) Fundamentals of Biochemistry for medical students, 7th Edition, Lippincott Williams and Wilkins.
2. Lehninger A.L, Nelson D.L and Cox MM (2013) The Principles of Biochemistry. CBS Publishers, New Delhi.
3. Lehninger, A.L., Nelson, D.K., and Cox, M.M. (2015) Principles of Biochemistry. CBS Publishers and distributors, New Delhi.
4. Moat A.G and Foster J.E (2008) Microbial Physiology. John Wiley and Sons, New York.
5. Murray, R.K., Granner, D.K., Mayes, P.A., Rodwell, V.W. (2017) Harper's Biochemistry. Prentice Hall International Inc.
6. Satyanarayanan, U (2015). Essentials of Biochemistry, Uppala Author – Publisher Interlinks, Vijayawada.
7. Stryer L (2010) Biochemistry.4th Edition, W. H. Freeman and Company, New York.
8. Stryer, L. (2016) Biochemistry. W.H. Freeman and Company, New York.
9. Voet D and Voet J.G (2012) Biochemistry.4th Edition, John Wiley and Sons, New York.
10. Voet. D. Judith, G. Voet, Charlotte W. Pratt. (2014) Fundamentals of Biochemistry, John Wiley & Sons Inc. New York.

Course Out comes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the chemistry of carbohydrates, lipids, proteins and amino acids	K1
CO2	classification and structural organization of proteins	K2
CO3	Explain the mechanism of enzyme action and identify the classes of enzymes and factors affecting action	K3
CO4	Identify the class and functions of secondary metabolites	K4
CO5	Select the significance of Biochemistry	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POS

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	S	M	M	S	S
CO3	M	S	M	S	S
CO4	M	M	S	S	M
CO5	M	S	M	M	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Elective – I	**Course Code:** 21PZO1E01		**Course Title:** Applied Entomology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	4	60	3	100

Course Objectives

1. To know taxonomical position and collection aspects of insects
2. To inculcate knowledge of morphology and physiology of insects
3. To impart knowledge about the growth and metamorphosis in insects.

UNT-I

Taxonomy and Insect Collection:. Classification of apterygota upto families- Classification of following insect orders (a) orthoptera (b) hemiptera (c) dipteral - C

Insect Collection: Methods- Preservation and Significance.

UNT-II

Comparative Morphology: Mouth parts of insects – Head- Thorax- Abdomen- Genitalia and Appendages Integument structure.

UNT-III

Anatomy and Physiology: Digestive system- Respiratory system- Circulatory system- Excretory system and Reproductive system.

UNT-IV

Insect culture practice: Apiculture – Sericulture and Lac culture. Insects as human food for future.

Veterinary Entomology: veterinary importance - Ecological factors affecting the population and development of Insects.

Vectors: Cattles vectors – Social life of insects – Hibernation and Aestivation insects.

UNT-V

Agriculture entomology: Pests of Vegetables – Pest of fruits – Pest of stored products

and Pest of paddy- Pest of sugarcane – Pest ground nut – Biology and Control measures.

Integrated pest management (IPM): Insect pest-Management strategies and tools - Biological control -Genetic control -Chemical control

Reference Books

1. Chapman R.F (2002) The Insects Structure and Function, 4th Edition, Cambridge University Press, United Kingdom.
2. Fenemore P.G. & A. Prakash (2002) Applied Entomology. New Age International (P) Publishers, New Delhi.
3. Imms, A.D (1972) Text Book of Entomology. Vol. I & II Ed. by Richard & Owen. ELBS.
4. Mani S (1968) General Eentomology. Oxford & IBH Publishing. New Delhi.
5. Nayar K.K. and T.N. Anathakrishnan and B.V. David. (1983), General and Applied Entomology, Tata McGraw Hill publishing Co. Ltd., New Delhi.
6. Tembhare D.B. (2009) Modern Entomology, Himalaya Publishing House, Delhi.
7. Vasantharaj David B and T. Kumarasami (2011). Elements of Economic Entomology, Popular Book depot, Madras – 15.
8. Wigglesworth V.B. (1979). The principles of insect physiology, ELBS and Chapman and Hall. U.K.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Get knowledge about the taxonomical position, collection, Identification and preservation of insects.	K1
CO2	Understand the morphology, structure and chemistry of integument.	K2
CO3	Apply knowledge in studying the behavior and physiology of Insects.	K3
CO4	Analyze the role of endocrine glands and their hormones in insect metamorphosis.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	S	S	S
CO3	S	M	M	S	S
CO4	S	S	S	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Elective – I		**Course Code:** 21PZO1E02		**Course Title:** Pathology and Clinical Laboratory Techniques
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	4	60	3	100

Course Objectives

1. To understand fundamental analytical principles and processes used in clinical laboratory testing.
2. To understand the practical and theoretical basis for laboratory test selection and interpretation.
3. To respond appropriately and effectively to situations commonly encountered when taking call.
4. To begin learning the body of knowledge needed for board exams
5. To obtain an understanding of the elements that contribute to professional competence, including patient care, medical knowledge, practice-based learning, interpersonal and communications skills, professionalism, and systems-based practice.

UNIT-I

Basic Laboratory Equipments- Light Microscopy -– Incubator - Hot Air Oven -Laminar Air flow- Water Bath –Centrifuge - Autoclave - Haemocytometer- Flame Photometer- Microtome – Glassware – Description of Glassware, its use, handling and Care

UNIT-II

Organization of clinical laboratory – Safety measures – Chemical, fire & Electrical – Lab Technician Duties and Responsibilities – Clinic borne infection and personnel hygiene Clinical Laboratory records – Quality control: Accuracy, Precision and Reference values, use of chemicals and their interactions - Danger signs, production techniques and Disposal methods.

UNIT-III

Cytology: Blood Smear preparation cytology – Fixation of smears – Staining – Fluid cytology – Urine- Sputum - Spinal fluid - Testing biopsy and Cytology specimens for cancer

UNIT-IV

Body fluids: Characteristics of Cerebrospinal Fluid – Synovial fluid – Pleural fluid – Pericardial fluids – Peritoneal fluids – Semen analysis- Physical, chemical & microscopic examination- Sperm count – Motility and Stool analysis.

UNIT-V

Urine – Composition, collection and Preservation, changes

in composition of urine in relation to various diseases – Complete urine analysis – Physical - Chemical – Glucose - Protein, reducing substances- Ketone bodies -Blood pigments and Bile Sediments.

Reference Books

1. Fischbach, (2005). Manual of Lab and diagnostic tests, Lippincott Williams Wilkins, New York.
2. Gradwohls, (2000). Clinical laboratory methods and diagnosis. (Ed) Ales C. Sonnenwirth and Leonard Jarret, M.D.B.I., New Delhi
3. Ochei.J and Kolhatkar, (2002). Medical Laboratory Science Theory and Practice, Tata McGraw -Hill, New Delhi.
4. Kanai L. Mukherjee, (2007), Medical Laboratory Technology Vol.1.Tata McGraw Hill, New Delhi.
5. Sood.R(2014) Laboratory Technology (Methods and interpretation) 4th Ed. J.P. Bros, New Delhi.
6. Shirley Mitchell Lewis, Barbara J. Bain, Imelda Bates (2006) Dacie and Lewis Practical Haematology, 10th Ed, Churchill Livingstone/Elsevier.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To understand fundamental analytical principles and processes used in clinical laboratory testing.	K2
CO2	To apply the practical and theoretical basis for laboratory test selection and interpretation.	K3
CO3	To analyse clinical, public health and management skill.	K5
CO4	Investigate the principles and uses of bioinstrumentation in medical laboratory.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	M	S
CO3	M	S	M	S	M
CO4	S	M	S	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Elective-I	**Course Code:** 21PZO1E03		**Course Title:** Biological Techniques	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	4	60	3	100

Course Objectives

1. To learn where things are in the lab.
2. To learn what the things in the lab are. This includes learning what things do, what they do not do, and where they should be used (if applicable).
3. To learn how to care for things in the lab.
4. To learn how to order and store supplies.
5. To learn some of the basic, most often used, most generally applicable: Tools, techniques, methodologies and methods of analysis used in biological research.

UNIT-I

Cytological Techniques: Microscopy – Compound Microscope and Electron microscope – TEM and SEM- Molecular cytological techniques- In situ hybridization (radio labelled and non-radio labelled methods) - Micrometry – Measurements using ocular and Stage micrometers – Measurements of cells from any prepared slide.

Cytological Techniques: Microscopy – Optical and electron microscopy – Phase contrast microscopy – Interference microscopy – Dark field- Polarization - Fluorescence and X-ray microscopy. Micrometry – Measurements using ocular and Stage micrometers – Measurements of cells from any prepared slide.

UNIT-II

Separation Techniques: Chromatography – Thin layer and Column chromatography – HPLC - GC and GCMS; Principles and Applications; AGE and PAGE; PCR and Blotting techniques; Centrifugation Principles and Types (differential and density gradient).

UNIT-III

Analytical Techniques: pH meter - Colorimeter -Visible and UV spectrophotometer- NMR- XRD – SEM - TEM bomb colorimeter and Atomic absorption spectrophotometer

UNIT-IV

Molecular Biology Techniques: Isolation and purification of RNA - DNA (genomic and plasmid) and Proteins, different separation methods. Isolation, separation and Analysis of carbohydrate and Lipid molecules –RFLP - RAPD and AFLP techniques.

UNIT-V

Applications of Bioinformatics in various fields: Drug designing - Medicine (molecular, personalized, preventive) - Gene therapy-Design of microbes for various applications (waste cleanup-forensic studies - Bio-weapons) – Bioengineering - Biological Computer, Computational methods of phylogenetic and Molecular evolutionary analysis

Reference Books

1. Boyer Rodney (2000). Modern Experimental Biochemistry, Person Education Asia, Delhi.
2. David, S.K. (1991). Handbook of histological and histochemical techniques, CBS Publishers and Distributors, Delhi.
3. Kannan S, Krishnan M, Thirumurugan R and Achiraman S (2012) Methods in Molecular Biology, UVN Publishers, India.
4. Santosh Kumar Mondal, (2017). Manual of Histological Techniques, Jaypee Brothers Medical Publishers, PP.180.
5. Veerakumari, L. (2009). Bioinstrumentation, MJP Publications, Chennai.
6. Wilson, K. and Walker, J. (2000). Practical Biochemistry, Cambridge University Press, Cambridge.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Students will demonstrate proper and safe, proper use of equipment, and the ability to use basic techniques in several areas and advanced techniques in at least one area.	K2
CO2	Apply the concepts of bio analytical techniques in biotechnology research.	K3
CO3	Learn the principles, methods and working mechanisms of microscopy.	K4
CO4	Handle these bio analytical techniques in industry.	K5
CO5	Operate and optimize the experimental conditions of different analytic techniques	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	S	M	M	S
CO3	S	M	S	S	M
CO4	M	S	M	S	M
CO5	S	M	S	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Lab Course – I	**Course Code:** 21PZO1P01		**Course Title:** Biology of Invertebrate and Vertebrates Cell and Molecular Biology and Biochemistry	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	4	60	5	100

Course Objectives

1. To observe various Invertebrate specimens by using Microscope.
2. To impart the practical knowledge on haematological studies
3. To understand the working principles and applications.
4. To learn how to quantify the biochemical substances and heritable traits.
5. To know the role of fauna in and around our ecosystem.

Invertebrates and Chordates

1. Structure and function of Major Mammalian Organs (Rat-heart, Pancreas, Liver, Kidney and Gonads) – Voucher Specimen
2. Spotters and Slides (For *Plasmodium sp*.- *Paramecium sp*.- Sponges- Hydra- Liver fluke- Tape worm and Peripatus.)

Cell and Molecular Biology

1. Micrometry for cell measurement
2. Identification of different types of cells in blood
3. Observation of Mitosis (onion root tip) and Meiosis (Grasshopper – Voucher Specimen)
4. Assessment of Cell division at various soil pH

Biochemistry

1. Qualitative analysis of Carbohydrate-Protein and Lipids
2. Estimation of glucose level in blood

3. Effect of Temperature on salivary amylase activity

4. Identification of amino acids by paper chromatography

Reference Books

1. Plumer H.T (2012) Practical: Biochemistry, Wiley Publication, India.

2. Borah D (2012) Biotechnology Lab Practices, Global Academic Publisher, India.

3. Kannan S, Krishnan M, Thirumurugan R and Achiraman S (2012) Methods in Molecular Biology, UVN Publishers, India.

4. Lal S.S (2009) Practical Zoology, Rastogi Publications, New Delhi.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand and study the section of certain animals from Coelenterata, Aschelminthes and Annelida to understand the evolution of different types of coelom.	K2
CO2	Evalute of prepared slides of mouth parts of Honey bee, Housefly, Thrips, Mosquito, Bed bug and Butterfly to relate structure and type	K5
CO3	Study of the following specimens: Amphioxus, Balanoglossus, Ascidian, Peteromyzon, Ichthyophis, Draco, Pigeon and Bat.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COS with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	S
CO2	M	S	S	S	M
CO3	S	S	S	S	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – V	**Course Code:** 21PZO2C05		**Course Title:** Animal Physiology and Endocrinology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	90	4	100

Course objectives

1. To get knowledge about the structure and functions of various systems.
2. To understand the physiology of digestion, respiration, circulation and muscle fiber.
3. To study the structure and functions of endocrine glands.
4. To gain basic understanding about endocrinology.

UNIT-I

Nutrition and Digestion

Metabolism: Types – Anabolism and Catabolism. Basal metabolic rate (BMR); Nutritive Requirements – Carbohydrates – Proteins - Lipids Vitamins and Minerals;
Physiology of Digestion: Role of salivary glands - Liver Pancreas and Intestinal glands in digestion. Symbiotic digestion – Cellulose digestion. Absorption and Assimilation – Hormonal control of digestion.

UNIT-II

Respiration and Circulation

Respiration- Comparative physiology of respiration in relation to different habitats- Aquatic habitat: Fishes, Terrestrial: Human respiratory system, Aerial: Birds and Insects, neural and chemical regulation of respiration.
Circulation: Blood – Composition of blood structure of human heart working mechanism of heart-peace maker and Conduction of heart beat – Blood coagulation. Lymph: composition, Dynamics and Haemostasis.

UNIT-III

Excretion, Osmoregulation and Thermoregulation

Excretion: Types of Excretion: Structure of mammalian kidney – Urine formation and Role of hormones in excretion.

Osmoregulation: Osmotic and ionic regulation in freshwater and Marine fishes – osmoregulation in terrestrial animals.

Thermoregulation: Thermoregulation in homeotherms and Poikilotherms. Comfort zone- body temperature – Physical, chemical, neural regulation and Acclimatization.

UNIT-IV

Muscle and Nerve Co-ordination

Muscles: Types of muscles – Chemistry of muscles – Ultra structure of skeletal muscles. Mechanism of muscle contraction.

Nervous system: Types of nervous system – Structure of Neuron – Types of Neuron conduction and transmission nerves impulses – Reflex action and Synapes action.

Receptor: Structure and physiology of photoreceptor (Human eye) and Phonoreceptor (Human Ear).

UNIT-V

Endocrinology and reproduction

Arthropod endocrines: Role of hormones in growth and Metamorphosis of Insects and Prawn.

Reproductive system: Structure of Human reproductive organs – Sexual cycle in mammals - Hormonal role in ovulation and Birth control.

Endocrine glands: Chemical structure and function hormones hypothalamus - Pituitary- Thyroid - Pancreas adrenal – Testes Ovary and Placenta. Hormones – Functions of hormones.

Reference Books

1. Schmidt-Nielsen K (1997) Animal Physiology, Cambridge University Press.
2. Randall D, Burggren W and French K (2002) Eckrett Animal Physiology, W. H.

Freeman Publications.

3. Sherwood L, Klandorf H and Yancey P (2012) Animal Physiology: From genes to organisms, Cengage Learning.
4. Prosser, C.L. and Brown (1985) Comparative Animal Physiology III Ed. W.B. Saunders Company, Philadelphia
5. Prosser C.L (1991) Comparative Animal Physiology, Environmental and Metabolic Animal Physiology, John Wiley and Sons.
6. Robert, H. Williams, M.D. (1981). Text book of Endocrinology, 6th Edition, Igakv Shoin, Aaunders International Edition. Tokyo, Japan.
7. Manning A and Dawkins M.S (2012) An Introduction to Animal Behavior, Cambridge University Press.
8. Breed, M.D and Moore J (2011) Animal Behavior, Academic Press, New York.
9. Gordon, M. S., Bartholomew, G. A., Grinnel, A. D., Jorgensen, C. B. White, F.N., (1971) Animal Function - Principles and Adaptations. Macmillan Co. London.
10. Goodenough J, McGuire B and Jakob E (2009) Perspectives on Animal Behavior, John Wiley and Sons.
11. Halliday T (1994) Animal Behavior, University of Oklahoma press, USA
12. Nussey S.S and Whitehead S.A (2013) Endocrinology: an integrated approach, CRC Press.
13. Hadley, M.E and Levine J.E (2007) Endocrinology, Prentice Hall.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Know the importance of nutrients and digestion.	K1
CO2	Understand the physiology of respiration, circulation and muscle.	K2
CO3	Impart knowledge on the role of renal organs in excretion.	K3
CO4	Describe the endocrine glands and their secretions.	K4
CO5	Evalute the basic control processes of the nervous systems and explain how this drives muscle movement and sensory perception associated endocrine system.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	M	M	S
CO3	S	S	S	M	S
CO4	M	S	S	S	M
CO5	M	S	S	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – VI	**Course Code:** 21PZO2C06		**Course Title:** Molecular Genetics	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	90	4	100

Course objectives

1. To get knowledge about the components of genetic material.
2. To know about genome and their role in inheritance.
3. To understand the relation between genes and diseases.

UNIT-I

Introduction to principles of Genetics: Dominant and Recessive Epitasis Multiples factor inheritance – Skin colour in Man. Co-dominance – Pleotropism – Lethal genes in Man and Mice.

UNIT-II

ABO and Rh type of Blood groups – Erythroblastosis foetalis - Haemophilia - Linkage and crossing over and Mapping of chromosome - Non-disjunction-Free Martin- Sex linked inheritance in Drosophilae and Man - Y-linked inheritance – Barr body- Extra chromosomal inheritance – Kappa particles – Coiling in Snail – Mirablis and Episome.

UNIT-III

Mutation :Mutagens-mutagenesis, types of mutation, mutator genes, sickle-cell anemia, forward and reverse mutation, frame shift mutation, site directed mutagenesis, transposable elements and transposition, and evolutionary significance.

Chromosomal Abreaction: Molecular basis of mutation – Polygenic inheritance - Transition and Transversion – Spontaneous and Induced mutations- Single Nucleotide polymorphism and Genetic disorders.

UNIT-IV

Chromosomal genetics:Heredity and variation Linkage maps- Tetrad analysis-Mapping with molecular markers.Genetic diseases (gout, hypercholesterolemia, cystic fibrosis, phenylketonuria, hemophilia, and muscular dystrophy),-Karyotyping- Pedigree analysis..

UNIT-V

Viral oncogenes- Activation of proto-oncogenes- Tumor suppressor genes- Regulation of gene expression by oncoproteins- Signal transduction by oncoproteins- Cell cycle check points and Cell line.

Reference Books

1. Dale J.W and Park S.F (2004) Molecular Genetics of Bacteria. 4th Edition, John Wiley and Sons Ltd., New York.
2. Gupta P.K. (2005) Genetics. III Ed. Rastogi Publication, India.
3. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley and Sons Ltd., New York.
4. Singh B.D (2009) Genetics, Kalyani Publishers, New Delhi.
5. Snustad D.P and Simmons M.J (2008) Principles of Genetics. John Wiley and Sons Ltd., New York.
6. Tamarin R.H (2001) Principles of Genetics (2001) 7th Edition, McGraw-Hill, New York
7. Verma, P.S. and V.K. Agarwal. (2010) Genetics, 21st Ed. S Chand Publishers, New Delhi.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Get knowledge about the structure, organization and functions of genetic materials.	K1
CO2	Understand the expression, regulation and mutation of gene.	K2
CO3	Apply the knowledge on the role of genes in heritability and its measurements.	K3
CO4	Analyze the importance of viral oncogenes, regulation of gene expression and signal transduction by oncoproteins.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	S	M	S	S
CO3	S	S	S	M	S
CO4	M	S	S	S	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
EDC-I	**Course Code:** 21PZO2EDC01		**Course Title:** Vermitechnology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	4	60	4	100

Course Objectives

1. To impart training on Earthworm culture technology.
2. To create knowledge on Self - Employment opportunity.

UNIT-I

Scope and importance of Vermitechnology: Classification of earthworm. Earthworm – External features, Digestive system, excretory system, reproductive system and Life cycle- Economic importance of Earthworm.

UNIT-II

Vermiculture: Methods of collection of earthworms. Steps involved in vermiculture. Factors influencing the culture of earthworms. Vermicomposting; steps of vermicomposting mechanism of vermicomposting and Changes in during vermicomposting.

UNIT-III

Methods of vermicomposting: Small scale or Indoor vermicomposting – Pit method. Heap method. Large scale or outdoor vermicomposting – Bed method, Window method vermitech

200. Vermiwash – preparation, composition and Application of vermiwash.

UNIT-IV

Vermicompost: Physical, chemical and biological characteristics of vermicompost. Nutritive value of vermicompost advantages and Economic importance of vermicompost. Use of vermicompost for crop production. Use of vermicompost in Land improvement and Reclamation.

UNIT-V

Role of earthworm in waste management: Solid waste management, Sewage waste management (Vermifilter), Faecal waste management, Industrial waste management. Role of earthworm in soil fertility earthworm as Farmer's friend.

Reference Books

1. Sultan Ismail (1997). Vermicology-The Biology of Earthworm, Orient Longman Limited, Chennai.
2. Edwards C .A and Lofty J .R (1977). Biology of Earthworms Chapman and Hall Ltd., London.
3. Lee K E (1985). Earthworms: Their ecology and Relationship with Soils and Land Use, Academic Press, Sydney.
4. Satchel J. E (1983). Earthworm Ecology, Chapman Hall, London.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Knowledge about sustainable agriculture, organic farming and waste management using vermitechnology.	K1
CO2	Understand the Earthworm- types, classification, organization and lifecycle.	K2
CO3	Apply the rearing and harvesting techniques in sericulture.	K3
CO4	Analyse the all aspects related to Vermicomposting and the economicsof Vermiculture	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	M	S	M	S	M
CO3	M	S	S	M	S
CO4	S	S	M	S	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
EDC-I	**Course Code:** 21PZO2EDC01		**Course Title:** Wild Life Management	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	4	60	4	100

Course Objectives

1. To know the wild life – Tourism foreign exchange. Important wildlife sanctuaries of the world.
2. To know the wild life in India such as wild life resources and sanctuaries.
3. To know the behavior of grazers (Elephants) carnivores (Lion) and primates (Orange, chimps and Gorillas).
4. To study the behavior and migration of Birds – various Bird sanctuaries Bird watching, fishing etc..

UNIT-I

Wild Life: Introduction Scope for the study of wildlife resources and forestry. Wild life Tourism. Foreign exchange and Revenue from Wildlife Tourism – Employment prospects. Important wildlife sanctuaries of the world. Need for the production and Conservation and conservation of wildlife and endangered species- Red data book.

UNIT-II

Wild Life In India: Important wildlife game reserves and sanctuaries in India, Gir Lion forest, Jim Carbett Tiger reserve- Kasiranga Sancturary- Point Calimere - Bharatpur Kaleodeo bird sanctuaries - Rann of Kutch - Mudumalai- Karkudi and Wynad sanctuaries and their wildlife species and Endangered species.

Unit-III

Ethology of Animal Behaviour

Grazers – Elephant – herds, their behaviour, family hierarchy, feeding, reproduction,

and Migration, Carnivores –Lions –family life, hunting behavior and Feeding, mating

and Reproduction, hierarchy, Primates – Larger primates – Orange, Chimps and Gorillas and Group behavior.

UNIT-IV

Bird Watching as hobby – Equipment needed for Bird watching, - Important migratory birds of India, check list of birds, Migratory behavior and Influencing factors. Fishing and sport / game fishes. Point Calimere- Vedanthagal – Muthupert - Bharatpur and other bird sanctuaries. **Unit-V**

Wildlife watching and tours as hobby and research. Wildlife filming. Videography and documentation. Silent Valley Project, Wildlife parks. Zoos, Treatment of animals in captivity and circuses. Wildlife conservation measures – Wildlife Protection Acts and Laws, World Wildlife conservation and funding agencies and programmes (WWF). Tiger projects (UNEP), ICUN (International Union for conservation of Nature and Natural Productively).

Reference Books

1. Charlie – Pye Smith., (1982) Insearch of Wild India, North, South Productions. Publishers, Boxtree Lted.
2. Terry Vaughan, A., W.B. (1972), Mammalogy, Saunders Company. London.
3. Encyclopedia of Animal World. Vol. I-XX, By Smith, North, South Productions, Publishers, Boxtree Ltd.
4. Salim Ali, (1978), Birds of India and Pakistan, By, Hindustan Publishers, New York.
5. Animal Behaviour, Times Illustrated World of Science, Time Life Asia.
6. Encyclopedia of Animal World, Vol.I-XX, by stargazers – Tatis, Bay Books, Sydney.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the wildlife management in India and National Parks and Sanctuaries.	K2
CO2	Analyze the Biodiversity hot spots, Endangered species and their Protection	K4
CO3	Evaluate the Wild life management Techniques and animal plant interaction.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	M	M	S
CO3	M	S	S	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Elective – II	**Course Code:** 21PZO2E04		**Course Title:** Cancer and Stem Cell Biology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	5	75	3	100

Course Objectives

1. To motivate students to learn the fundamentals of cancer
2. To enable the students to know how the stem cells are functioning
3. To get knowledge about different types of molecular techniques.

UNIT-I

Regulation of the Eukaryotic cell cycle- Cancer biomarkers - Primary and established cell lines, Kinetics of Cancer cell growth- Genetics of cancer biology. Cancer stem cell culture and their applications. Cell culture-based vaccines and Cancer proteomics at a glance

UNIT-II

Cell Signaling in Cancer Cells and Signaling at the cell surface level- Types of signaling pathways that control gene activity in normal and cancer cells - Endocytotic and Exocytotic proteins in membranes and Organelles - Vascular traffic - Metabolism and Movement of lipids.

UNIT-III

Etiology- Epidemiology Diagnosis and Treatment of Breast, Lung, and Colo-rectal, cancers. Current scenario of micro-RNA technology in cancer medicine. Role of DNA vaccination in cancer treatment.

UNIT-IV

Introduction to Stem cells– Stem cell definition, origin and Hierarchy; stem cell properties, Identification and Characterization- Potency and Differentiation; niche of stem cell; overview of different stem cell types (Embryonic stem cell, Adult stem cell and Induced pluripotent stem cells)

UNIT-V

Characterization and properties of ES cells -Pluripotency and self-renewal of ES; molecular mechanisms regulating pluripotency Mesenchymal stem cell (MSC), Haematopoietic stem cell (HSC) pluripotent stem cell (iPSC), Gene therapy – Therapeutic cloning. Ethical and Social consideration of Stem cell research.

Reference Books

1. Committee R (2004) Stem Cells and the Future of Regenerative Medicine by on the Biological and Biomedical Application of Stem Cell Research.
2. Kiessling, A.A. (2006). Human Embryonic Stem Cells (Second Ed.) Jones & Barlett Publishers.
3. Korobkin R and Munzer SR (2007) Stem Cell Century, Law and Policy for a Breakthrough Technology, Yale University Press.
4. Lanza R (2004) Hand Book of Stem Cells Volume 1and2, Elsevier press.
5. Lanza, R. (2005). Essentials of Stem Cell Biology. Academic Press.
6. Lodish H, Kaiser C.A, Brasher A, Amon A, Berk A, Kreger M, Ploegh H and Scott M.P (2012) Molecular Cell Biology, 7th edition, Garland Publishing, Inc. New York.
7. Robertis E.D.P and De Robertis E.M.F (2005) Cell and Molecular Biology, (8th Edn), De, B.I. Waverly Pvt. Ltd., New Delhi.
8. Turksen K (2002) Embryonic Stem Cells Method and Protocols. Humana press.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand key theoretical aspects of the regulation of cellular signalling, proliferation and differentiation in the context of embryonic development, stem cells and diseases such as cancer.	K1
CO2	This course work provides chance to work in stem cells and cancer stem cells.	K2

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COS with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	M	M	M	M	S
CO2	M	S	S	M	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Elective – II	**Course Code:** 21PZO2E05		**Course Title:** Microbiology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	5	75	3	100

Course objectives

1. To provide students with the latest information in microbiological methods.
2. To provide advanced knowledge, understanding, and critical judgment about the profession in microbiology.
3. To update basic knowledge on microorganisms.
4. To understand the economic importance of microbes in relation to agriculture, industry and medicine.

UNIT-I

History and Scope of Microbiology: Wittaker's Five Kingdom concept - General features of prokaryotes. Morphology and Ultra-structure of viruses. Mycology: Classification of bio medically important fungal species.

UNIT-II

Culture and Characterization: Isolation and identification of bacteria. Techniques of pure culture methods. Phases of growth. Methods of sterilization and Disinfection –. Staining: Simple and Differential staining-Gram staining- Acid fast staining Endospore staining- Capsule staining and Flagella staining.

UNIT-III

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction. Microbial Genomics: Gemone project of Escherichia coli and Yeast. Metagenomics concepts and Significance. Microbial control – Physical and chemical agents

UNIT-IV

Host parasite interaction: Principles of Disease and Epidemiology –

Microbial Mechanisms of Pathogenicity Innate Immunity: Nonspecific Defenses of the Host Adaptive Immunity: Specific Defenses of the Host

UNIT-V

Industrial Microbiology: Microbial fermentation Microbial production of Antibiotics: Penicillin-Streptomycin - Vaccines - Genetic recombinant vaccines. Bioremediation Principles and Applications.

References Books

1. Atlas R.M. (2001) Principles of Microbiology. 2nd Edition, Tata McGraw-Hill, New Delhi.

2. Dubey R.C and Maheswari D.K (2014) Textbook of Microbiology. S. Chand and Co. New Delhi

3. Edition, Macmillan Press.

4. Gerard J. Tortora, Berdell R. Funke, Christine L. (2017) Case, Microbiology: An Introduction, 12th Edition Pearson publishers, USA

5. Pelczar M. J, Chan E.C.S and Kreig N.R (2015) Microbiology. Tata-McGraw Hill, New Delhi.

6. Prescott L.M (2016) Microbiology. 6th Edition. McGraw-Hill, New Delhi.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Apply the knowledge on microorganisms classification, importance and application	K1
CO2	Observe the role of microorganisms on food processing, environment, microflora on human health and disinfectication methods	K2
CO3	To develop a heightened sense of understanding in students about the microscopic world around them.	K3

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	M
CO3	S	M	M	S	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Elective – II	**Course Code:** 21PZO2E06		**Course Title:** Biotechnology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	5	75	3	100

Course Objectives

1. To understand the basic knowledge of Nano-Biotechnology.
2. To enhance the synthesis and application of Nano-materials in medicine and agriculture.
3. To apply Nano-Technological knowledge on the DNA, Proteins, Nucleic acids, drug delivery and biomedicine.

UNIT-I

Concepts and scope of Biotechnology – Gene cloning the basic steps – various types of restriction enzymes – Ligase – linkers and Adapters – cDNA – Transformation – Selection of recombinants. Gene probe – Molecular finger printing (DNA finger printing) – RFLP –PCR techniques – Genomic library.

UNIT-II

Plasmid biology – Cloning vector based on *E. coli*-PBR322 and Bacteriophage. Cloning vector for yeast. Cloning vector for Agro Bacterium Tumefaciens. Cloning vector for mammalian cells – Simian virus 40 – Gene transfer technologies.

UNIT-III

Cell culture – Organ culture – Whole embryo culture- Embryo transfer – *In vitro* fertilization (IVF) technology – Dolly – Embryo transfer in human. Transgenic animal. Human gene therapy and Cryobiology

UNIT-IV

Bioinformatics: Basic concepts of Bioinformatics - Sequence Databases - Sequence formats – Gene basic - Networking – Network access- Internet, E.mail servers – Use of databases biology - Sequence databases - Sequence Analysis – Protein and Nucleic acids- Structural comparisons

UNIT-V

Nanotechnology: Basic principles and scope of Nanotechnology – Structural and Brownian assembly – Important characteristics – Molecular manufacturing – Decisive military capabilities – Molecular mills in the fields of agriculture – Medicine - Future perspectives of Nanotechnology in Life Sciences and Applications of Nanotechnology.

Reference Books

1. Challa, S.S.R. Kumar, Josef Hormes, Carola Leushaer, (2005). Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact, Wiley-VCH.
2. Houdy. P, Lahmani M. Marano F. (2011). Nano-ethics and Nanotoxicology. Springer Verlag Berlin Heidelberg.
3. Niemeyer CM, and C. A. Mirkin. (2004). Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH.
4. Rajendran, V., Saminathan, K., Paramasivam, P., Geckeler, K.E., (2012). Nanomaterials Synthesis and Charecterization", Bloomsburry Publishing India PVT. LTD, New Delhi.
5. Rathy R.K, (2009). Nanotechnology, S. Chand Publisher.
6. Sidharth Baliyan, (2011). Basics of Nanotechnology, Anmol Publications Pvt. Ltd.
7. Simeonova P.P., N. Opopol and M.I. Luster, (2007). Nanotechnology – Toxicological Issues and Environmental Safety, Springer.
8. Thomas E., Twardowski (2007). Introduction to nanocomposite materials. Properties, Processing, Characterization. DES Tech Publications, USA.
9. Vinod Labhasetwar and Diandra L. Leslie, (2007). Biomedical Applications of Nanotechnology, A john Willy & Son Inc., NJ, USA.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the various Applications of Biotechnology.	K2
CO2	Apply and Understand the Hybridoma technology as well as Enzyme biotechnology.	K3
CO3	Analyse the DNA Recombinant technology.	K4
CO4	Understand the industrial and environmental biotechnology.	K5
CO5	Create the Stem cell biotechnology.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	M	S	S	M	S
CO3	S	S	M	S	M
CO4	S	M	S	M	S
CO5	S	M	M	S	M

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Lab Course – II		**Course Code:** 21PZO2P02		**Course Title:** Animal Physiology and Endocrinology and Molecular Genetics
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	5	60	5	100

Course Objectives

1. To determine the physiological action in relation to temperature, PH and osmotic pressure.
2. To acquire the practical knowledge about primary metabolites and its estimation in higher organisms.
3. To inculcate knowledge on aquaculture.

Animal Physiology and Endocrinology

1. Salt loss and salt gain in a fresh water fish
2. Preparation of Haemin crystal in human blood
3. Estimation of O_2 consumption of fresh water fish

Human Molecular Genetics

1. ABO Blood group in human
2. Study of Polytene chromosome in the Drosophila larva

Spotters

Ciliated epithelium - Cardiac muscle T.S-Bone tissue T.S -Simple squamous Epithelium- Nervous tissue. Transverse section of Pituitary - Thyroid- Pancreas - Adrenal- Thymus-Ovary and Testis

Reference Books

1. Nigam S.C and Omkar (2006) Experimental Animal Physiology and Biochemistry, New Age International
2. Zsolt Peter Nagy, Alex C. Varghese, Ashok Agarwal, (2013) Clinical Embryology: A Practical Guide, Springer-Verlag New York.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To Gain knowledge about the molecular genetics.	K1
CO2	Understand the role of primary metabolites.	K2
CO3	Apply the knowledge on the physiological changes in relation to Temperature, PH and Osmotic Pressure.	K3
CO4	Evaluate the physiological and biomedical parameters.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	M	S	S	S	S
CO3	S	M	M	S	M
CO4	S	S	S	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – VII		**Course Code:** 21PZO3C07		**Course Title:** Aquaculture
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	6	90	4	100

Course Objectives

1. To explore the aquatic resources of the edible and economically important organisms.
2. To make use of the inland waters and marine potential to substitute the protein requirements by the human population.
3. To provide self-Employment opportunities and knowledge for students.

UNIT-I

Historical background and present status of aquaculture: Purpose and importance of aquaculture.

Aquaculture : History and present status in India

Types of culture systems: Traditional- Extensive-semi-intensive-Intensive-super-intensive. Characteristic features of cultivable species (Indian major carps- Murrels- Catfish and Tilapia). Selection criteria of cultivable species.

Cultivable species – fin fishes and shell fishes – composite carp culture,Tilapia culture in freshwater – shrimp farm in coastal water.

UNIT-II

Types of aquaculture: Design construction of pond management – Types of ponds. Control of aquatic weeds and Predators.

Feeding biology – Live feed organisms (Algae, Phytoplankton, Rotifers, Artemia etc.) – Supplementary feeds – Simple feed, compound feed, food conversion Ratio (FCR), Fed formulation, Types of feed.

UNIT-III

Mono sex culture - Culture of air-Breathing fishes- Sewage fed fish culture- Fish-cum duck culture: Induced breeding of carps and Brood stock management.

UNIT-IV

Fish diseases: Parasitic- Protozoan- Bacterial- Fungal and viral diseases and their control measures. Fish processing and preservation-fishery by-products. Principles of Fish Health Management- Fish vaccines and Antibiotics.

UNIT-V

Genetic improvement of stock – Selective and diversified breeding – Hybridization – Transgenic fishes (Antifreeze & Green fluorescent proteins). Chromosomal manipulation-

Ploidy in Fishes- Gynogenesis and Androgenesis in Fishes

Reference Books

1. Biswas S.P (1993) Manual of Methods in Fish Biology, International Book Co., Absecon Highlands, New Jersey.
2. Bose A.N, Yang C.T and Misra A (1991) Coastal Aquaculture Engineering. Oxford and IBH Publishing Co., Pvt. Ltd., New Delhi.
3. Jhingran V.G (1991) Fish and fisheries of India. Hindustan Publishing Corporation, New Delhi.
4. Pillai T.V.R (1993) Aquaculture Principles and Practices. Fishing News Agency, London.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Get knowledge about the production of cultivable candidate fish species	K1
CO2	Understand the global, national, traditional and modern techniques related to fishes for food security	K3
CO3	Apply practical knowledge into the aquaculture field to enhance production level	K4
CO4	Analyze students theoretical and technical knowledge useful for teaching, research, extension and entrepreneurship in the field of Aquaculture	K5
CO5	Learn the scientific method of setting an aquarium.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	M	M
CO2	S	M	M	S	M
CO3	S	S	M	S	S
CO4	S	S	M	M	S

S- Strong, M – Medium, L – Low

Program: M.Sc. Zoology				
Core – VIII	**Course Code:** 21PZO3C08		**Course Title:** Immunology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	6	90	4	100

Course Objectives

1. To motivate students to learn the lymphoid organs of our body.
2. To make them understand the different types of immune globulins.
3. To get knowledge about different types of techniques used in immunology.
4. The objective of this course is to make students understand the existence of microbial world and diversity along with their origin and scope in present day life.

UNIT-I

Immunity: Kinds of immunity – Natural and acquired. Primary lymphoid organs – Thymus, Bursa of Fabricus- Bone marrow. Secondary Lymphoid organs – Spleen- Lymphnodes- Payer's Patches.

UNIT-II

Antigens and Antibodies: Antigen Types, properties - Haptens, Adjuvants – vaccine types. Immunoglobulin- Structure, types and properties. Theories of antibody production. Complement system- Structure, properties, function of complement component and Pathways.

UNIT-III

Antigen – Antibody Interactions: Characteristics feature of Ag – Ab reaction - Precipitation, Agglutination-Opsonisation - Cytolysis-Flocculation-Complement fixation. Major Histocompatibility complex – Autoimmuno disease - Hybridoma technology (MCA)- Corona virus – T cells interaction with Covid – 19 virus

UNIT-IV

Hypersensitivity: Hypersensitivity and this types, Type I – Anaphylactic Hypersensitivity Type II – Antibody dependent hypersensitivity. Type III – Immune complex mediated hypersensitivity - IV – Cell mediated hypersensitivity - V-Stimulated hypersensitivity and

Tolerance.

Vaccines: Vaccine and Types of vaccine – Vaccination schedule and immunization schedule.

UNIT-V

Principles and applications of immune techniques

Blotting Techniques: Southern Blotting-Northern Blotting- Western Blotting – ELISA – RIA Immunofluorescence technique – Microarray as a tool for detection of human genetic disorders. Immunodiagnostics and Immunotherapy for tumor.

Transplantation: Types of Transplantations – Autoplastic Transplantation (skin), Homoplastic (eye, Kidney) transplantations, Graft acceptance, Immunosuppressors, Graft rejection. Types of allograft rejection, and prevention of allograft rejection.

REFERENCE BOOKS:

1. Abbas, A. K., and A. H. Lichtman (2017) Cellular and molecular immunology, First- South Asia Edition, Elsevier

2. Delves, P., S. Martin, D. Burton and I. M. Roitt, (2017), Roitt's Essential Immunology, 13th Edition, Wiley – Blackwell publications, USA

3. Murphy, K.M., and Weaver, C (2017) Janeway's Immunology, 9th edition, W.W. Norton & Company, USA

4.Paul, W.E. (2012) Fundamental Immunology, 7th Edition, Lippincott Williams and Wilkins, USA

5.Punt. J., Stranford, S., Jones, P., W. A. Owen (2018). Kuby Immunology 8th Edition, W.H. Freeman & Company, New York.

6.Tizard, I.R. (1995) Immunology-An introduction IV Ed. Saunders College Publications, Philadelphia, USA.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO 1	The students will get more knowledge about lymphoid organs	K1
CO 2	The students could differentiate the immunoglobulin based on their structures	K2
CO 3	Students get overview knowledge about immunology	K3
CO 4	Understand the Immunological instrument and its applications	K4 & K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
CO2	M	S	M	S	S
CO3	S	M	S	M	S
CO4	S	S	M	S	M

S- Strong, **M – Medium,** **L – Low**

Program: M. Sc. Zoology				
Core – IX	Course Code: 21PZO3C09		Course Title: Developmental Biology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	5	75	4	100

Course Objective

1. To learn about the developmental stages of an embryo.
2. To obtain the knowledge of fertilization and differentiation of mammals.
3. To understand the organogenesis, nutrition, regeneration and teratogenesis of mammals.
4. To familiarize the student with the principle of developmental biology and provide him a bird's eye view of sophisticated embryological techniques.

UNIT - I

Scope of embryology- Gametogenesis: Spermatogenesis – Oogenesis- -Structure of Egg and sperm- Physico - chemical changes during fertilization. Parthenogenesis-Natural and artificial.

UNIT -II

Cleavage : Salient features–planes of Cleavage – patterns of cleavage – Types of blastula – **Gastrulation** : Morphogenetic movements- Gastrulation in frog and man. Molecular changes during gastrulation- Activity of Genes during gastrulation.

UNIT - III

Organogenesis: Fate map in frog - Development of Brain and eye

Extra embryonic membranes in Chick. Placenta: Types placenta -Placenta of Mammals- Regeneration: Types of regeneration -Events in regeneration**.**

UNIT-IV

Organizer : Spemann's experiments and conclusions – Types of embryonic Induction (Primary, Secondary, chain of induction) –Experiments on Chemical nature of inducing substance – Mechanism of induction .Transplantation: types of transplantation- nuclear transplantation

UNIT –V

Fertility- Antifertility and Infertility defects and Treatments. Assisted reproductive Technology (ART) in man – Artificial insemination (AI), In vitro Fertilization (IVF) - Embryo Transfer (ET) - Gamete Intra-fallopian Transfer (GIFT) and Zygote Intra-fallopian Transfer (ZIFT). Immuno - contracption Cryopreservation of gametes and Embryo. Sexual gene –egg bank-sperm

bank –nuclear transplantation and cloning

Reference Books

1. Balinsky B.L. (2008) An Introduction to Embryology W.B. Sounders Company Publication, Philadelphia.

2. Bruce M (2007). Carlson Foundations of Embryology, McGraw Hill Publishing Companies. 3. Jain, P.C (1998) Elements of Developmental Biology Vishal Publication, New Delhi.

4. McEwen, R.S. (1969) Vertebrate Embryology Oxford and IBH Publishing Co., New DelhiPublication.

5. Munish Kainth (2013) A Textbook of Chordate Embryology, Wisdom Press, Dominant Book Publications.

6. S.Banerjee (2005) Developmental Biology Dominant Publishers and Distributers, New Delhi. 7. Scott F. Gilbert Sinaver (2008) Developmental Biology, Amociates Sunderland

8. Veer Bala Rastogi and M.S. Jayaraj (2008) Developmental Biology, Keendarnath Ramnath 9. Verma P.S and V.K. Agarwal (2014) Chordate Embryology S. Chand Publication Company Ltd., New Delhi.

Course Outcomes

On successful completion of the course, the students will be able to

CO 1	Get knowledge about the spermatogenesis oogenesis and ovulation in human	K1
CO 2	Understand the mechanism of fertilization , metabolic activities and molecular changes in cleavage process in human	K2
CO 3	Study the development of various organs and physiology of Human	K3
CO 4	Study the mechanism of induction, major events during regeneration and teratogenesis	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	M	S

S- Strong, **M – Medium,** **L – Low**

Program: M. Sc. Zoology				
Core – X		Course Code: 2PZO3C10		Course Title: Research Methodology
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	5	75	4	100

Course Objective:

1. The objective is to develop basic computing skills and application of quantitative and statistical operations required for biological studies and rationalization of experimental designs.

UNIT-I

Data: Types of data – Methods of data collections. – Bar and pie Diagram -Measures of Central Tendency: Mean - Median and mode (single and grouped data) - **Sampling methods** Random sampling, Stratified random Measures of Dispersion: Range- standard deviation (SD) and standard error (SE).

UNIT-II

Correlation: Types of correlation – coefficient of correlation. Regression: Types Regression co efficient Regression Probability Distribution: Normal distribution- Binomial distribution and poison distribution.

UNIT-III

Anal**ysis of variance:** One-way classification - Two-way classification.

Goodness of Fit Tests: Chi-square test for goodness of fit. Student's t-Test.

UNIT-IV

Thesis writing: Research formulations: Basic concepts of research- meaning- objectives- motivation and approaches. Defining and formulation of research problem – Literature review – Importance- Research ethics –Plagiarism.

Hypothesis: null and alternate hypothesis and testing of hypothesis – Theory, principles- Law and Canon. Data collection technique. Selection of problem – Stages in execution of research- Preparation of Manuscript – Thesis format.

UNIT-V

Scientific Documentation and Communication: Project proposal writing - Research report writing: thesis and dissertation; preparation of manuscript. Standard of Research journals: Peer review – Impact factor –Citation index. Choice of journals for publication.- Significance of Scopes and Web of Science- h-index i-10 index.

Information retrieval: Archives, Databases and search Engines: Google- PubMed -Online database library - e-journals and e-book

Research paper: Oral and poster presentation. Synopsis- facing viva-voce using LCD.

REFERENCE BOOKS

1. S.P. Gupta, 2006. Statistical methods. Sultan Chand and sons- 23, Daryagans, New Delhi- 110002.
2. Gurumani, N. (2003) Biostatistics. Tamilnadu Book House.
3. Milton, J.S. (1992) Statistical Methods in Biological and Health Sciences. McGraw – Hill Inc., New York.
4. Schefler, W.C. (1968) Statistics for biological sciences. Addision - Wesley Publication Co., London.
5. Snedecor, G.W. and Cocharn, W.G. (1967) Statistical Methods. Oxford & IBH Publication Co., New Delhi.
6. Sokal, R.R. and Rohlf, F.J. (1969) Biometry. The principles and Practice of Statistics in Biological Research.W.H. Freeman and Co., San Francisco.
7. Kumar, B.P, 2007. Introduction to Bio-Statistics. S Chand & Company; 3rd Rev. Edn. New Delhi, India

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO 1	Gain the knowledge on basic biostatistics calculations	K1 & K2
CO 2	Gain knowledge on distributions	K3
CO 3	Students are able to predict the significance of the biological phenomenon on the basis of available data set.	K4
CO 4	Statistics has proved to be useful in study of all natural sciences and also applied in research work	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	M	S	S	S	M
CO3	S	S	M	M	M
CO4	S	M	S	S	S

S- Strong, **M – Medium,** **L – Low**

Program: M.Sc. Zoology				
Lab Course – III	**Course Code:** 21PZO3P03		**Course Title:** Aquaculture, Immunology Developmental Biology and Research Methodology	
Semester III	**Hours/ Week** 6	**Total Hours** 90	**Credits** 5	**Total Marks** 100

Course Objectives

1. To Analyze and inculcate the fundamental knowledge on immune system and immunological responses to antigens.
2. To provide the fundamental knowledge on instruments, statistical methods and Applications.
3. To know the fundamental principles computer Applications.

Aquaculture

1. Effect of salinity on opercula movement of a freshwater fish
2. Aquaculture farm visit
3. List of cultivable fresh water fish
4. Estimation O_2 fresh water
5. Estimation of Co_2 fresh water

Immunology

1. Lymphoid organs- Primary and Secondary.
2. Immunoglobulins: IgA, IgG, IgM and Ig E.
3. Blood Group Testing

Research Methodology

1. Calculation of Mean, Median, Mode for the distribution.
2. Calculation of Standard deviation for the frequency distribution.

Developmental Biology

1. Blastoderm Mounting of Chick/Duck embryo.
2. Amphibia - Identification of developmental stages.
3. Preparation of sperm suspension and observation of Spermatozoa in Bulls Semen. Study of rate of motility of sperm in Bulls Semen (Demonstration Only)

Spotters

Lymphoid organs – Thymus- Spleen Lymph node Bursa of fabricius - Peyer's patches- Macrophages – HIV - Bacteriophage- Key board – Mouse – CPU- Hard disk and Printer

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To gain knowledge on microbes of biosphere.	K1
CO2	Understand more knowledge in the operations of advanced Immunological equipment.	K2
CO3	Analyse the role of computer applications and bioinformatics tools in Biological data interpretation.	K4
CO4	Evalute the ecological significance and their management.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	S	S	S
CO3	M	S	S	M	M
CO4	S	M	M	S	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Core – XI	**Course Code:** 21PZO4C11		**Course Title:** Evolution	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
IV	5	75	4	100

Course Objectives

1. To provide comprehensive overview of concept of evolution
2. To explain origin of life especially prokaryotes as well as Eukaryotes in detail
3. To explore salient features of various theories of evolution comprising of Lamarckism-Darwinism and Neo-Darwinism
4. To provide adequate information about Geological time scale and Natural theory of Molecular Evolution
5. To provide glimpse of Phylogenetic Trees and highlight their construction along with interpretation

UNIT-I

Introduction: Origins of evolutionary thought- Origin of Life – Principles of Lamarckism – Neo-Lamarckism - Darwinism –Neo- Darwinism – Speciation and Types of speciation.

UNIT-II

Hardy-Weinberg Law: Gene pool – Gene frequency - Hardy-Weinberg equilibrium and Application of Hardy Weinberg law.

Mutation: Mutation and Gene flow with reference to Rates of evolutionary change - Genetic drift and Non-random breeding – Reproductive.

Isolating mechanisms: Various types Isolation mechanism

UNIT-III

Phenotypic variation: Behavior as phenotypic traits-variation within and among species

The "Niche" concept. Natural selection: Stabilizing-Directional and Disruptive selection – Social interaction and evolution of cooperation- theories of cooperation and altruism-inclusive fitness and reciprocation - Interaction among related individuals-evidence for evolution by kin selection.. Ecogeographic rules: Subspecies concepts – Clines and Hybrid zones.

UNIT-IV

Mimicry and coloration: Mimicry types of mimicry – Coloration and types of coloration

Evolutionary trends and Laws: Gradualism and Punctuated equilibria – Adaptation and adaptive radiation with reference to convergent and divergent evolution and Evolution of horse.

UNIT-V

Evolutionary innovations and the origin of higher taxa- Evolution of *Homo sapiens* and molecular biological and immunological evidences for evolution. Impact of DNA bar coding in modern Evolutionary studies. Cultural evolution of man.

REFERENCE BOOKS:

1. Wilson EO (2000) Sociobiology: The new synthesis, Harvard University.
2. Hall BK and Hallgrimsson B (2011) Strickberger's Evolution, Jones and Bartlett Publishers.
3. Futuyma DJ (2013) Evolution, Sinauer Associates, USA.
4. Minelli A (2009) Perspectives in Animal Phylogeny and Evolution, Oxford University Press, UK
5. Dobzhansky T (1970) Genetics of the evolutionary process, Columbia University Press.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Students can understand and describe fundamental processes of evolutionary change, including genetic drift, natural selection and mutation.	K2
CO 2	Students can understand and describe fundamental processes of evolutionary change, including genetic drift, natural selection and mutation.	K1 & K2
CO 3	Students can use perturbations of Hardy-Weinberg equilibrium to infer activity of specific evolutionary processes	K2 &K3
CO 4	Understand how these processes lead to small- and large-scale patterns of evolutionary change, including diversification, adaptation, and complexity	K4
CO 5	Students can comprehend implications of a single ancestor of all life on our planet, including a tree-like history of diversification and major adaptive transitions in the evolution of life.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

CO	PO 1	PO2	PO 3	PO 4	PO 5
CO 1	S	S	M	S	S
CO 2	S	S	M	S	S
CO 3	S	M	S	S	M
CO 4	S	S	S	M	S
CO 5	S	S	M	S	S

S- Strong, M – Medium, L – Low

Program: M.Sc. Zoology				
Core – XII	**Course Code:** 21PZO4C12		**Course Title:** Environmental Biology	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
IV	5	75	4	100

Course Objectives

1. To obtain knowledge about the biosphere and their characteristics.
2. To know the energy, natural resources and their conservations.
3. To get information about the space ecology.

UNIT-I

Environment: Abiotic and Biotic factors – Atmosphere - Light - Temperature - Atmospheric Pressure – Wind - Humidity and Rainfall. Structure and function of ecosystem - Pond as an Ecosystem.

UNIT-II

Soil formation, components of soil -Physico-chemical properties of soil - Structure texture and Classification of soil- Soil organisms-Soil erosion (degradation).

UNIT-III

Water Resources- Hydrological cycle – Characteristics of Ponds – Lakes – Rivers- Estuaries - Mangroves and their conservations – Fauna and flora of Mangroves.

UNIT-IV

Community Ecology: Food web – Food chain - Ecological pyramids - Energy flow in Ecosystem – Concept of community ecology and Ecological Niches.

Environmental Pollution: Types of environmental pollution and their biological effects. Air pollution – Water pollution and Noise pollution – causes, effects and control.

UNIT-V

Radiation Ecology: Wild life management – Radiation Ecology: Remote sensing - Space ecology – Exobiology and Hazards of space travel. Energy resources and Disaster Management – Renewable and Non renewable resources,

Reference Books

1. Agarwal K.C. (1989), Environmental Biology, Agro Botanical Publishers (India).
2. Biswarup Mukerjee (1997), Environmental Biology, Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. Charles R. Goldman, Alexander J. Horsno Mcgraw (1983), Limnology – Hill International Book Company, New Delhi.
4. Dilip Kumar (2010), Introduction to Soil Science, Das Kalyani Publishers, New Delhi.
5. Edward John Kormandy (1969), Concept of Ecology, Prentice Hall Publishers New Delhi.
6. Joseph M. Moran, Michael, P. Morgan, James, H. Wiesma (1991), Introduction to Environmental Science, W.H. Freeman and Company, Sanfrancisco.
7. Odum E.P. (1971), Fundamentals of Ecology, 3rd Edition, W.B. Saunders & Co., Philadelphia.
8. Sharma P.D., (2012), Ecology and Environment, Rastogi Publications, India.
9. Singh J.P., Singh S.P and S.R. Gupta (2014), Ecology Environmental Science and Conservation, S. Chand Publishers, New Delhi

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Expertise knowledge about the biosphere.	K1
CO2	Understand the physical, chemical and biological characteristics of the biosphere.	K2
CO3	Apply the knowledge in measuring the energy resources and the conservation of natural resources.	K3
CO4	Analyze the techniques of the remote sensing and space travel.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	M	S	S
CO3	M	M	M	S	S
CO4	S	S	M	M	S

S- Strong **M – Medium** **L – Low**

Program: M. Sc. Zoology				
Core – XIII		Course Code: 21PZO4C13	Course Title: Economic Zoology	
Semester	Hours/Week	Total Hours	Credits	Total Marks
IV	5	75	4	100

Course Objectives

1. To understand the significance of sustainable agriculture, medical, veterinary, aquaculture and food processing.

UNIT I

Apiculture: Types of Honey bee – Life history of Honey bee – Bee colony – Collection of Honey – Medicinal value of Honey and Bee wax artificial Bee hive – Enemies and disease of honey bees and their control methods.

UNIT II

Sericulture: Scope of Economics of Sericulture – Types of culture (Eri, Tasar- Muga and Mulberry silk worm) – Mulberry cultivation –Varieties of Mulberry- Life cycle of *Bombyx mori* – Disease and pest of Silkworm – Prevention and control measures.

UNIT III

Aquaculture: Economics of aquaculture – Water quality Management – Composite fish culture – Integrated fish farming – Hypophysation Techniques – By products of fishery- Prawn culture – Economic of Prawn culture – Aquaculture Institution in India.

UNIT IV

Vermiculture: Vermiculture and Vermicomposting – Classification of earthworm – Rearing technology – Vermiwash Preparation – Composition and Application - Types of Vermicomposting: Small scale and Large scale method – Economic importance of vermicompost.

UNIT V

Poultry farming – Important breeds of poultry – Construction of poultry house – Cage house and Deep litter system – Poultry nutrition – diseases and their prevention - Management of Broilers.

REFERENCE BOOKS:

1. Bremner, H.A. (2002) Fish as Food, Vol 1 & 2, Elsevier 2. Mishra, R.C., (1985), Honey Bees and their Management in India, ICAR.
2. Ullal, S.R. and Narasimihanna, M.N. 1977. Hand Book of Practical Sericulture, Central Silk Board, Bombay.
3. Fish and Fisheries – Kamaleshwar Pandey and J.P.Shukla, Rastogi Publication.
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5. Agarwal, W.C. – Economic Zoology
6. Shammi, Q.J. and Bhatnagar, S., 2002, Applied Fisheries: ISBN-81-7754-114-5 Agrobios (India), Jodhpur – India.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Understand the economic importance of agricultural entomology	K1
CO 2	Describe the communicable and non-communicable diseases in humans	K1 & K2
CO 3	Explain the importance of animal husbandries	K3
CO 4	Understand the culture practice and economic importance aquaculture	K4
CO 5	Λearn various techniques for food preservation and preparation of value added products.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

MAPPING of COs with POs

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	S	M	M	S	M
CO 2	S	S	M	S	M
CO 3	S	M	S	M	M
CO 4	S	S	S	M	S
CO 5	S	S	M	M	S

S – Strong **M – Medium** **L – Low**

Program: M.Sc. Zoology				
Lab Course – IV	**Course Code:** 21PZO4P04		**Course Title:** Evolution, Environmental Biology and Economic Zoology	
Semester IV	**Hours/Week** 4	**Total Hours** 60	**Credits** 5	**Total Marks** 100

Course Objectives

1. To enable the students to understand how living systems evolved.
2. To understand the mechanism of evolutionary changes through adaptation, natural selection, speciation and the history of life.
3. To support to do experiments on Environmental Biology
4. To learn how do we enhance the productivity in Economic Zoology

Evolution

1. Study of Fossils (Ammonoids, Nautiloids & Echinoderm fossils).

Environmental Biology

1. Estimation of pH in water samples
2. Estimation of Dissolved CO2 in water samples,
3. Estimation of Dissolved Oxygen
4. Estimation of Salinity in water samples,
5. Identification of plankton in different water samples

Economic Zoology

1. Identification of pests and diseases of mulberry.
2. Identification of various types of silkworms and silk moths and their external morphology.
3. Various stages of larva and their identification in *Bombyx mori.*
4. Identification of important pest and diseases of silkworm *Bombyx mori.*
5. Dissection and display of silk gland of *Bombyx mori* (V instar larva).

Spotters

Animal inter relationship, (Parasitism, parasitic castration, Commensalism, Mutualism) Food chain and food web - energy flow - fossil any two -Rain cage- Fossils- Mulberry Pests any two.

Course Outcomes (COs)

On successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Use foundational practical knowledge to carry out research in the specified area.	K1
CO2	Analyze the results and to collect the basic information in the field of zoology.	K4
CO3	Evaluate the research findings and present them in written and oral.	K5
CO4	Implement the research findings for the pollution free environment upliftment of mankind.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	M	S	S	S

S – Strong **M – Medium** **L – Low**