Annexure 10.1

Avinashilingam Institute for Home Science and Higher Education for Women

Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD (now MoE)
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Department of Zoology
M.Sc. Zoology

Programme Outcomes:

1. Acquire in-depth knowledge in science, gain technical and experimental skills in Zoology.
2. Enhancing the capacity to think critically, design and execute experiments independently and as a team under multidisciplinary settings.
3. Successful cope up with modern scientific trends through digital literacy to handle biological data.
4. Strengthen the ethical values to develop personal, professional and research ethics.
5. Imbibe a self-paced and self-directed learning ability to carry out independent research.
6. Identify the individual's entrepreneurial skills in life sciences.

Programme Specific Outcomes:

1. Understand the fundamentals and application oriented knowledge in Zoology.
2. Create graduates in the fields of Zoological sciences to develop innovative products for societal approaches.
3. Expand entrepreneurial opportunities in Zoological sciences and train students to clear competitive exams at national level.

Scheme of Instruction and Examination
(For students admitted from 2025 – 2026 & onwards)

Part	*Subject Code*	*Name of Paper / Component*	*Hours of instruction / week*		*Scheme Examination*				
			T	**P**	**Duration of exam**	**CIA**	**CE**	**Total**	**Credit**
First Semester									
I	25MZOC01	Structure and Functions of Invertebrates	4		3	40	60	100	4
	25MZOC02	Comparative Anatomy of Vertebrates	4		3	40	60	100	4
	25MZOC03	Cell and Molecular Biology	4		3	40	60	100	4
	25MZOC04	Genetics	4		3	40	60	100	4
	25MZOC05	Practicals I – Invertebrates and Vertebrates		6	3	40	60	100	3

	25MZOC06	Practicals II – Cell and Molecular Biology and Genetics		6	3	40	60	100	3
II		**CSS/ Adult Education / Community Engagement and Social Responsibility**	2	-	-	-	-	-	
		Second Semester							
I	25MZOC07	Biochemistry and Biophysics	5		3	40	60	100	5
	25MZOC08	Animal Physiology and Endocrinology	5		3	40	60	100	5
	25MZOC09	Developmental Biology	4		3	40	60	100	4
	25MZOC10	Evolution	4		3	40	60	100	4
	25MZOC11	Practicals III –Biochemistry, Biophysics, Animal Physiology, Endocrinology, Developmental Biology and Evolution		6	3	40	60	100	3
II		Interdisciplinary course	4	-	3	100	-	100	4
		Professional Certification Course							2
	25MXCSS1/ 25MXAED1/ 25MXCSR1	**CSS / Adult Education / Community Engagement and Social Responsibility**	2	-	2	-	-	100	2
		Internship during Summer Vacation (1 month)							
		Third Semester							
I	25MZOC12	Biostatistics and Bioinformatics	4		3	40	60	100	4
	25MZOC13	Microbiology and Biotechnology	3		3	40	60	100	3
	25MZOC14	Immunology	4		3	40	60	100	4
	25MZOC15	Environmental Biology	3		3	40	60	100	3
	25MZOC16	Practicals IV- Bioinformatics, Microbiology, Biotechnology, Immunology and Environmental Biology		6	3	40	60	100	3
	25MZOC17	Mini Project	1			100	-	100	2
	25MZOC18	Entrepreneurial Avenues in Zoology (Self Study Course)	2		3	100	-	100	2
	25MZOC19	Internship						100	2
II		Multidisciplinary course	2		3	100	-	100	2
	25MZOSC1	Sustainability Course Economic Entomology	2	3	3	100	-	100	Remark
		Fourth Semester							
I	25MZOC20	Research Thesis/Project/Patent		**30**		100	100	200	20
								Total Credits	**96**

Other courses to be undergone by the student:

*** MOOC courses- 2 to 4 Credits – Credit transfer may be claimed.**

Minimum 96 + 2 Credits to earn the degree

** Students who exit at the end of 1st year shall be awarded a **Postgraduate Diploma**.

Courses offered by the department:

Interdisciplinary Course - 25MZOI01 – Ornamental Fish Farming
Multidisciplinary Course -25MZOM01 – Wildlife Conservation and Ecotourism
Professional Certification Course - 25MZOPC1- Conservation Biology

Structure and Functions of Invertebrates

Semester I — Hours of Instruction / week: 4

25MZOC01 — No. of credits: 4

Course Objectives:

1. To discuss their classification, structural and functional aspects of invertebrates.
2. To understand the systemic and morphological features of invertebrate animals.
3. To study the economic values and affinities of invertebrates.

Unit 1 **General Principles of Animal Taxonomy** 12 hrs

Principles and methods of Taxonomy - Concept of species-Hierarchical taxa-Biological Nomenclature-Biological classification- Rules of Binomial nomenclature-Classical and quantitative methods of taxonomy -Outline classification ofminor and majorPhyla -Important criteria used for classification in each taxon and evolutionary relationships among taxa -Numerical Taxonomy-New trends in Taxonomy-Species concept-Levels of structural organization-Symmetry-Coelom-Metamerism* - Molecular Systematics and DNA Barcoding

Unit 2 **Locomotion and Feeding** 12 hrs

Locomotion and adaptive mechanism in invertebrates–Flagellar and Cilliary movement in Protozoa-Hydrostatic movement in Coelenterata,Annelida and Echinodermata -Structure and diversity of skeletal elements in Protists and Non-Chordates. Feeding - Patterns of feeding- Filter feeding in Polychaeta, Crustacea, Mollusca and Echinodermata.

Unit 3 **Respiration and Circulation** 12 hrs

Organs of respiration - Gills (Crustacea), lungs (Pila), and trachea (Insecta), Book lungs (Arachnida) –Respiratory pigments-Mechanism of respiration.

Circulation–Cyclosis (Paramecium), Diffusion (Sponge) - *Open circulatory system (Cockroach) and Closed circulatory system (Nereis).

Unit 4 **Nervous system and Sense organs** 12 hrs

Primitive nervous system in Coelenterata and Echinodermata - Advanced nervous system in Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda) - Trends in evolution of nervous system.

*Sense organs -Photoreceptor - Simple and Compound eye-Mechanoreceptor Statocyst and Osphradium -Chemoreceptor - Nuchal organs -Thigmoreceptors - Tactile -Olfactory receptors andProprioceptors in different taxa.

Unit 5 **Excretion and Reproduction** 12 hrs

Excretion in Protists and its types-organs of excretion in invertebrates - Coelom, Coelomoducts, Nephridia, Green glands and Malphigian tubules - Mechanisms of excretion and Osmoregulation. Reproduction - Asexual (Paramecium), Alternation of generation (Obelia) -Sexual (Fasciola and Nereis) -*Larval forms of free-living invertebrates and Parasitic helminths -Evolutionary significance of larval forms.

***Self-study** **Total: 60 Hours**

Text Books:

1. Ekambaranatha Ayyar.(2002) Manual of Zoology, Vol (I).Invertebrates, S.Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
2. Kotpal RL.(2014). Modern Text Book of Zoology, Invertebrates (9th Edition) Rastogi Publications, Meerut.

Reference Books:

1. E.J.W. Barrington (1979) Invertebrate Structure and Functions, East West PressPvt., Ltd.
2. Holland, P.(2011) The Animal Kingdom: A Very Short Introduction,Oxford University Press, Oxford.
3. Janet Moore (2012).An introduction to Invertebrates,Cambridge University Press,Cambridge.
4. Eisenhour, David, Allan Larson, Susan Keen, Larry Roberts, Cleveland Hickman Jr.(2014). Animal Diversity, Boston: McGraw-Hill International, USA.
5. Ruppert, Fox andBarness. (2015). Invertebrate Zoology: A Functional Evolutionary Approach,
   7 th Edition, Cengage India.
6. Brusca Richard(2016).Invertebrates Third edition,Sunderland,Massachusetts USA.

CourseOutcomes:

1. Develop taxonomic skills in invertebrates among students
2. Understand the various structures used for locomotion and feeding strategies
3. Explore the diversity of respiratory organs and circulatory system
4. Impart knowledge of the nervous system and sensory organs.
5. Explicate the excretory mechanism and larval forms ininvertebrates.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	L	L	H	M	L
CO 2	H	M	H	L	M	L	H	M	L
CO 3	H	H	H	M	H	M	H	H	M
CO 4	H	H	H	M	M	M	H	H	M
CO 5	M	H	M	H	H	H	M	H	H

Comparative Anatomy of Vertebrates

Semester I — Hours of instruction / week: 4

25MZOC02 — No of credits: 4

Course Objectives:

1. To know the principles of vertebrate classification
2. To understand the evolution of organ systems
3. To understand the distinctive characteristics of major vertebrate groups

Unit 1. **Outline classification of Vertebrates upto orders with examples** — 10 hrs

Taxonomy- Principles of Taxonomy*Origin of chordates – jawless vertebrates, Super class Pisces and super class Tetrapoda – Adaptive radiation from aquatic to terrestrial organisms. Migration – migration of Fishes and Birds

Unit 2. **Vertebrate integument and its derivatives** — 10 hrs

General structure of integument and functions and *its derivatives - Glands, Scales, Horns, Claws, nails, hoofs, feathers and hairs, Poisonous and non poisonous snakes. Economic importance of vertebrates.

Unit 3. **Circulatory and Respiratory systems in Vertebrates** — 15 hrs

General plan of circulation and its regulation in various vertebrate groups, blood, lymph, coagulation, Evolution of heart and aortic arches and portal systems

*Respiration – Internal and external respiration, Respiratory pigments, Respiratory organs and Types of respiration, accessory respiratory organs in vertebrates

Unit 4. **Nervous system** — 10 hrs

Comparative anatomy of the brain in relation to its functions; Nerves– cranial and peripheral nerves - *Autonomous nervous system, neuromuscular junction in vertebrates. Temperature regulation in poikilotherms, homeotherms and heterotherms

Unit 5. **Urinogenital system in Vertebrate** — 15 hrs

Types and Functions of Kidneys - Pro, Meso and Meta nephric kidneys

Reproductive system, *Male and Female Gonads and Gono ducts - accessory reproductive glands, parental care of vertebrates. Endocrine glands in vertebrates.

***Self Study**

Total Hours: 60

Text Books:

1. Kotpal RL. Modern text book of Zoology- Vertebrates, Rastogi publications.2020
2. Ekambaranatha Ayyar, M and Ananthakrishnan ,T.N Manual of Zoology, Vol. II, Chordata, Ananda Book Publishers 2019
3 Mathur, V. and Pandey, BN. Biology of Chordates. India: PHI Learning Pvt.Ltd.2018.

Reference books:

1. Kingsley JS Text book of vertebrate Zoology, New York, H.Holt 2010.
2. Asha Sharma. Vertebrates (Structure and Functions), Ramesh Book Depot,New Delhi 2008
3. Kotpal RL. Modern Text Book of Zoology, Vertebrates (5^{th} Edition) Rastogi Publications, Meerut, 2020 - 21.
4. Varma, PS and Jordan EL. Chordate Zoology, Kindle edition 2013.
5. Dev Bhattacharya.Text book of Chordate Zoology, WAVE Books Publishers, 2023
6 Harris, R. J. and Mcmillan, D. An Atlas of Comparative Vertebrate Histology. Netherlands: Elsevier Science. 2018.
7 Jameson, E. W. Patterns of Vertebrate Biology. United States: Springer New York. 2012

Course Outcomes:

1. Understand the unique features, taxonomy and functional morphology of different classes of vertebrates.
2. Explore the role of integument and its derivatives in major vertebrates groups.
3. Knowledge of evolution of heart and lungs of vertebrates.
4. Compare the anatomy of vertebrate nervous system in perception to phylogenetic evolution.
5. Explore the structure and function of specific organization of vertebrates.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	H	H	H	H	H
CO 2	H	M	H	M	H	H	H	H	H
CO 3	H	M	H	M	H	L	H	M	H
CO 4	H	L	H	M	H	L	H	H	H
CO 5	H	M	H	M	H	H	H	H	H

Cell and Molecular Biology

Semester I — Hours of Instruction/week : 4

25MZOC03 — No. of credits : 4

Course Objectives:

1. To understand structural and functional components of the cell
2. To elucidate molecular mechanism of cell functioning
3. To Illustrate process of proteins synthesis and regulation of gene expression

Unit 1. **Membrane structure and cell signalling** — 12 hrs

Structure of model membrane- lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. General principles of cell signalling, types and mechanisms. Cell surface receptors, GPCR Molecular structure and functions, enzyme linked receptors, Activated tyrosine kinase and MAP kinase pathways

Unit 2. **Cell division and structural organization** — 12 hrs

Strategies of cell division- Mitosis and meiosis, central cell cycle control system- cell cycle check points- cyclin and cyclin dependent kinases –control of cell cycle. Structural organization and function of intracellular organelles-Nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, Protein sorting & targeting cytoskeleton and its role.

Unit 3. **Cancer biology and Cell Ageing** — 12 hrs

Cancer-Types and their prevalence, carcinoma, lymphoma and malignancy. Classification based on tissue types. Molecular biology of tumor invasion and metastasis- Role of proto- oncogenes in regulating cell growth and survival, mechanisms of activation of oncogenes. Therapeutic interventions. Cell aging process and its significance. Mechanism of cell death- Cell necrosis and apoptosis. CASPASE types and molecular mechanisms, proapoptotic regulators, inhibitors of apoptosis and anti-ageing process

Unit 4. **DNA replication, repair, RNA synthesis and gene expression** — 12 hrs

DNA Replication- enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons. DNA damage and repair mechanisms; RNA synthesis- Transcription factors and machinery- formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination. RNA processing, RNA editing, splicing, poly adenylation, structure and function of different types of RNA, RNA transport; Regulation of gene expression in prokaryotes and eukaryotes*

Unit 5. **Stem Cell Biology and regenerative medicine** — 12 hrs

Introduction to stem cells –Types - Embryonic stem cells, adult stem cells, hematopoietic stem cells, mesenchymal stem cells, cancer stem cells, induced pluripotent stem cells. Differentiation of mesenchymal stem cells into various lineages. Induced Pluripotent Stem Cells (iPSCs)*; Isolation, characterization and maintenance of embryonic stem cells; Applications of stem cells in neurodegenerative diseases, spinal cord injury, eye diseases; Ethical and regulatory practices.

*Self study

Total Hours: 60

Text Books:

1. Petter JR (2016). Genetics- A Molecular Approach, Third edition, Pearson Education, New Delhi.
2. De Robertis 8th Edition (2020) Cell And Molecular Biology.
3. Channarayappa. (2010). Cell biology, First edition, Orient Black Swan/ University Press, New Delhi.
4. Janet I, Wallace M. Karp.(2018). Cell and Molecular Biology-Concepts and Experiments, Eighth Edn. John Wiley & sons Inc., USA.

Reference Books:

1. Cooper GM, Hausman RE. (2009) The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2009) The World of the Cell, VIII Edition, Benjamin Cummings Publishing, San Francisco
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments, VI Edition, John Wiley & Sons Inc
4. David C, Nanette P, Michelle M (2019). Molecular Biology, Third Edn, Academic cell, Elsevier.
5. King R.J.B and Robbins M.W (2006) Cancer Biology,3rd ed., , Pearson Education Ltd
6. Ajoy Paul (2009).Text book of Cell and Molecular Biology, Second Edn, Books and Allied (P) Ltd, Kolkata, India.

Course Outcomes:

1. Able to describe transport across cell, cell-cell communication and mechanisms of signal transduction.
2. Outline the processes that control eukaryotic cell cycle.
3. Understand the cellular mechanisms that lead to cancer growth and molecular response in cell ageing
4. Illustrate the concepts of central dogma of molecular biology spanning from DNA Replication till Protein Synthesis.
5. Acquire extensive theoretical knowledge on stem cell and regenerative medicine and imbibing awareness of professional, ethical and social responsibilities

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	L	M	H	M	H
CO 2	H	M	H	M	L	M	H	M	H
CO 3	H	M	H	H	M	M	H	L	H
CO 4	M	M	H	M	M	M	H	H	H
CO 5	M	M	H	M	L	M	H	H	H

Genetics

Semester I — Hours of Instruction/week : 4

25MZOC04 — No. of credits : 4

Course Objectives:

To facilitate the students

1. To understand the principles and mechanisms of the inheritance from one generation to the next
2. To gain knowledge on futuristic aspects of genetic diseases, treatment and preventive options.
3. To get updated with the mechanism of inheritance by scientific experimentation.

Unit 1 **Mendelian principles** : Dominance, segregation, independent assortment *Mendelian traits in man. — 15 hrs

Modifications of Mendelian principles :Codominance, incomplete dominance, gene interactions, pleiotropy, Complemetary, Supplementary, Epistatic, Lethal and cumulative genes- genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, cis and trans arrangement of genes, sex linkage, sex limited and sex influenced characters.

Unit 2 **Concept of gene** :Allele, multiple alleles, ABO blood group and Rh factor, isoalleleandpseudoallele, — 15 hrs

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Organelle inheritance: Extra nuclear inheritance – Shell coiling in snails, inheritance of kappa particles in Paramecium, Sigma particles in Drosophila. Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance*

Unit 3 **Sex determination and Human Genetics** — 10 hrs

Genetic, hormonal, metabolic and environmentally controlled sex determining mechanism; Human chromosomes- Classification and Identification – Lyons hypothesis – Barr body and heterochromatin- Autosomal and sex chromosomal abnormalities in man – Amniocentesis- Chromosomal aberrations - Pedigree charts – lod score for linkage testing, Eugenics and genetic counselling - Human genome project*

Unit 4 **Population and Applied Genetics** — 10 hrs

Gene pool and gene frequencies – equilibrium of gene frequencies – Hardy-Weinberg equilibrium – Rate of changes in gene frequencies through natural selection; Animal Breeding – History, Aims, Methods – Inbreeding, Outbreeding and hybrid vigour*

Unit 5 **Regulation of gene expression and Microbial Genetics**

Concept of operon of bacteria and bacteriophages.Utility of the model organisms: *Escherichia coli, Arabidopsis thaliana, Caenorhabditis elegans, Drosophila melanogaster &Musmus culus.*

Methods of genetic transfers- Transformation - Gendralised and specialised Transduction and sexduction, - Conjugation –F^+ X F^- mating, HFr conjugation, F^1 conjugation, Transposons-Discovery, Characteristics, types of transposable elements - Ac and Dc elements, Retrotransposans, IS Elements*. — 10 hrs

***Self Study** — **Total Hours: 60**

Text books

1. Strickberger M W. 2012. Genetics (Macmillam). Prentice Hall of India Pvt Ltd. New Delhi.
2. Sinnott, E. W. Dunn, L.C. Dobzhansky Theodosius. 1993. Principles of genetics . McGraw-Hill publications, New York
3. Gardner E J. Simmons M J. Snustad D P. Principles of Genetics. VIII Edition. Wiley India 2008.
4. Russell P J. Genetics- A Molecular Approach.III Edition. Benjamin Cummings 2009.

References

1. Klug, W S., Cummins, M R., Spencer, C., Palladino, M A. 2020. Concepts of Genetics.10th Edition. Pearsons Publication.
2. Benjamin A.Pierce. 2000. Genetics: A Conceptual approach. 7th edition. McMillan Publication.
3. Snustad D P. Simmons M J. Principles of Genetics. V Edition. John Wiley and Sons Inc 2009.
4. Griffiths A J F. WesslerSR.Lewontin RC. Carroll SB. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co 2007.
5. Fletcher H. Hickey I. Genetics. IV Edition. GS, Taylor and Francis Group, New York and London 2015.

Course Outcomes:

1. Comprehensive, detailed understanding of the chemical basis of heredity
2. Understand and describe the mechanisms that underpin biological inheritance
3. Acquire the knowledge to design, execute, and analyze the results of genetic experimentation in animal, plant model systems and human being.
4. Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.
5. Construct relevant, targeted and comprehensive personal and family histories and pedigrees and integrate genetic testing options in genetic counselling practice

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO 1	PSO 2	PSO 3
CO 1	H	-	H	M	H	-	H	H	H
CO 2	H	H	H	H	H	M	H	H	H
CO 3	H	H	H	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	H	H	H

Practicals I-Invertebrates and Vertebrates

Semester I — Hours of instruction / week: 6

25MZOC05 — No of credits: 3

Course Objectives:

1. To learn computer aided Simulated animal dissection
2. To study the representative organisms of each phylum of both invertebrates and vertebrates
3. To observe the birds and other animals from their natural habitats through field visits

Invertebrate	**Dissections**	16 Hrs
	Pila - Digestive and Nervous system	
	Sepia - Nervous system	
	Cockroach and Grasshopper - Digestive system	
	Prawn - Appendages	
	Earthworm – Virtual	
	Mouthparts Mounting	
	Honey bee, Mosquito and Bed bug – Sucking	
	House fly – Sponging	
Slides and Spotters - Invertebrata		
Protozoa	Amoeba,(Binary fission) Paramecium, Plasmodium, Euglena and Balantidium	2 Hrs
Porifera	Leucosolenia, Euplectela, trilobite Spicules, T.S. of sponge and Gemmule of Sponge	2 Hrs
Coelenterata	Hydra, Obelia colony and medusa, Sea anemone, Madrepora, T.S. of Hydra and Tubipora	2 Hrs
Platyhelminthes	Fasciola, Planaria, Taeniasolium, Turbellria, T.S. of liver fluke and Ascaris	2 Hrs
Annelida	Neries, T.S. of Nereis, Chaetopterus, Earth worm, and Arenicola	2 Hrs
Arthropoda	Daphnia, Cyclops, Naupilus, millipede, and cetipede	2 Hrs
Mollusca	Fresh water mussel, Mytilus, Octopus, Sepia and Pila	2 Hrs
Echinodermata	Starfish, Sea urchin, Sea cucumber and Sea anemone	2 Hrs
	I. Collection of five species of insects belonging to a clade.	5 Hrs
	II. Taxa, identification techniques: Mosquito/ Butterfly/Dragonfly	5 Hrs
Vertebrates	Shark, Magill or Tilapia – Digestive system	16 Hrs
	Albino rat or mouse – Arterial and Venous system	
	Simulated animal dissections of frog (Virtual)	
	Skull preparation	
Spotters - Vertebrata		
Pisces	Norcine, Mullet, and Diodon	2 Hrs
Amphibia	Ranahexadactyla, and Icthyophis,	2 Hrs
Reptilia	Calotes, Chameleon, Draco, and Viper or Cobra	2 Hrs
Aves	Pigeon, Woodpecker,Crane and King fisher	2 Hrs
Mammalia	Bat, Loris, Rabbit, Rat, Pig, and Sheep embryo	2 Hrs

I. Construct a Cladogram by grouping invertebrate organisms together based on their shared derived characteristics. **12** Hrs

II. Praparation of 5 permanent slides practical work done during the semester at the time of practical examination

III. Identify and report systematic position of any 5 animals in your syllabus

IV. Comparison of two species of birds and animals belonging to same genus (Interspecific difference)

V. Observe and exhibit different kinds of feathers

VI. Understanding the limb pattern from pisces to mammals

Field Visit Visit to Zoos and National park 10Hrs
Visit to Wild Life Sanctuaries
Visit to Salim Ali Centre for Ornithology
Visit to Mandapam Regional Centre of ICAR-CMFRI
Visit to agricultural field

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

Total Hours: 90

Course Outcomes:

1. Introducing the structure, function and behaviour of select invertebrate types through the observation of simulated animal dissections.
2. Reinforcing basic laboratory skills including microscopy, simulated animal dissection and careful observation
3. Providing with the ability to recognize the major groups of invertebrate
4. Record the fauna of different phylum and families through the visit to Gass Museum
5. Learn the keys for the identification of bird watching through the visits to Salim Ali centre for ornithology

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	H	H	H	H	H
CO 2	H	H	H	M	H	H	H	H	H
CO 3	H	H	H	M	H	H	H	H	H
CO 4	H	H	M	H	M	M	H	H	H
CO 5	H	H	M	H	M	M	H	H	H

Practicals II - Cell and Molecular Biology and Genetics

Semester I — Hours of Instruction/week : 6

25MZOC06 — No. of credits : 3

Course Objectives:

1. To acquire skills in squash preparation, permanent slides and staining.
2. To develop practical skills in the advanced techniques of Molecular Biology
3. To enable the use of model organisms in understanding the genetic principles.

Cell Biology	1. Slides on tissues – Epithelium- squamous, cuboidal, striated, pigmented, elastic cartilage, connective, bone, muscular, germ cells.	2 hrs
	2. Preparation of buccal smear and identification of Barr body	3 hrs
	3. Squash preparation of onion root tip and observation of mitotic stages	5 hrs
	4. Cell size determination using micrometer	4 hrs
	5. Histology - Study of different cell types (animal cells)	5 hrs
	6. Permanent slides: Meiotic stages (mounting from cockroach testes)	5 hrs
	7. Demonstration of osmotic studies using human red blood cells	5 hrs
	8. **Histology:** Fixation, dehydration, embedding, sectioning, staining and permanent mounting of tissues - Submission of 5 best slides for Exam evaluation	7 hrs
Molecular Biology	1. Isolation and estimation of DNA from fish tissue	5 hrs
	2. Staining of DNA Feulgen technique	3 hrs
	3. Isolation of plasmid DNA from bacteria	5 hrs
	4. Demonstration of AGE – separation and molecular weight determination of DNA	5 hrs
	5. Restriction endonuclease digestion of DNA	5 hrs
	6. Demonstration of PAGE - separation and molecular weight determination of proteins.	5 hrs
	7. Demonstration of DNA fingerprinting and DNA Sequencing-Sanger's Method (Virtual aid)	1 hr
Genetics	1. Culture of *Caenorhabditis elegans* and Drosophila and identification of phenotypic traits –model organism	2 hrs
	2. Study of various genetic traits in man	3 hrs
	3. Study on autosomal and sex chromosomal abnormalities	2 hrs
	4. Preparation of questionnaire and report of genetic counselling and prenatal diagnosis of pregnant women in family	5 hrs
	5. Construction and analysis of pedigrees for genetically inherited diseases (any five)	3 hrs
	6. Karyotyping of human chromosome (Demonstration)	5 hrs

7. Exercises for multiple alleles and multiple genes 3 hrs
8. Case Studies for genetic diseases- Any three popular personalities 2 hrs

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

Total Hours: 90

Course Outcomes:

1. Understand transport across cell, cell-cell communication and mechanisms of signal transduction.
2. Outline the processes that control eukaryotic cell cycle.
3. Conceptualize and describe vesicular trafficking of secretory proteins and cell secretions.
4. Represent and illustrate the structural organization of genes and the control of gene expression
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	M	H	L	H	H	H
CO 2	M	H	M	H	H	M	H	H	H
CO 3	M	H	H	M	H	L	H	H	H
CO 4	M	H	M	H	H	M	H	H	H
CO 5	M	H	H	M	H	H	H	H	H

Biochemistry and Biophysics

Semester II
25MZOC07

Hours of instruction / week: 5
No of credits: 5

Objectives:

1. To understand the chemical basis of life.
2. To study the structure, metabolism and biological significance of biomolecules
3. To enable students to understand the basic principles, working mechanism and applications of biophysical techniques

Unit 1. **Bioenergetics and Biological Oxidation** — 15 hrs

Bioenergetics – Concept of free energy, endergonic and exergonic reactions, Relationship between free energy, enthalpy and entropy, laws of thermodynamics, Redox potential, High energy compounds, biological significance of ATP and cyclic AMP*

Biological Oxidation – Enzymes involved in biological oxidation, Electron transport chain - Components and structural organisation of electron transport, Oxidative phosphorylation- Chemiosmotic hypothesis, Uncoupling of oxidative phosphorylation, mitochondrial transport systems - malate/glycerol phosphate shuttle

Unit 2. **Carbohydrates and Lipids** — 15 Hrs

Carbohydrates – Classification, structure and functions - Monosaccharides, Disaccharides, Polysaccharides - Homo and hetero polysaccharides
Metabolism – Reactions and energetics of Glycolysis and TCA cycle, HMP shunt, glycogenesis, glycogenolysis, gluconeogenesis

Lipids - Classification, structure and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, lipoproteins and steroids
Metabolism - Biosynthesis of fatty acids, β oxidation of palmitic and valeric acid, ketogenesis*

Unit 3. **Amino acids, Proteins and Enzymes** — 15 hrs

Amino acids - Structure, classification and properties
Metabolism - Transamination, deamination and decarboxylation, urea cycle, inborn errors of metabolism

Proteins - Classification, levels of protein structure, bonds related to protein structure - Conformation of proteins by Ramachandran plot, domains, motif and folds, Protein turnover*

Enzymes – Characteristics, Structure, Nomenclature, Classification, Active site, Mechanism of enzyme action, Factors affecting enzyme action, Enzyme inhibition, Coenzymes, Isozymes, Ribozymes and Abzymes

Unit 4. **Biophysical techniques I** — 15Hrs

Electrochemical techniques – Determination of pH by hydrogen electrode and glass electrode, Buffer systems of body fluids and pH maintenance*
Centrifugation – Principle, types and applications of preparative and analytical ultracentrifuges

Chromatography – Principle, methodology and applications of thin layer, High Performance Liquid Chromatography, Gas liquid chromatography

Unit 5. **Biophysical techniques II** 15 hrs

Spectroscopy – Principle, types of spectra – absorbance, emission and fluorescence Types of spectroscopy – Principle, instrumentation, working methodology and applications of UV-visible spectroscopy, atomic absorption spectroscopy, Fourier transform infrared spectroscopy, Mass spectrometry, Nuclear magnetic resonance spectroscopy

Total Hours: 75

Text Books:

1. Kennelly PJ, Botham KM, McGuinness OP, Rodwell VW and Weil PA.. Harpers Illustrated Biochemistry, Thirty Second Edition, Tata McGraw Hill Companies' Publication, USA, 2022.
2. Nelson DL and Cox MM. Lehninger Principles of Biochemistry, Eighth edition, MacMillan Publishing Company, UK, 2021.
3. Satyanarayana U and Chakrapani U. Biochemistry, Sixth Edition, Elsevier Publications, New Delhi, 2023.
4. Wilson K, Walker J, Practical Biochemistry – Principles and Techniques, Eighth Edition, Cambridge University Press, India, 2018.

Reference Books:

1. Berg J, Gatto GJ, Hines J, Tymoczko JL, Stryer L. Biochemistry, Tenth Edition, W.H. Freeman & Company, New York, 2023.
2. Voet D, Voet JG, Pratt CW, Fundamentals of Biochemistry – Life at the Molecular Level, Sixth edition, John Wiley and Sons Inc., New York, 2024.
3. Boyer R, Concepts in Biochemistry, Third Edition, John Wiley and Sons Inc., United States, 2006.

Course Outcomes:

1. Understand the concepts of fundamental energetics of biochemical processes and biological oxidations
2. Gain knowledge on the basic structure and functions of biomolecules
3. Understand the metabolic pathways and their regulatory mechanisms
4. Recognize the importance of buffer systems in pH maintenance
5. Apprehend the principle, operation, and applications of various techniques for analyzing biomolecules

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	L	L	M	H	M	H	M	H
CO2	H	L	M	H	L	H	H	M	H
CO3	M	L	M	L	M	H	H	H	H
CO4	H	M	L	H	H	H	H	M	H
CO5	H	H	H	H	H	H	H	H	H

Animal Physiology and Endocrinology

Semester II — Hours of Instruction/week : 5

25MZOC08 — No. of credits : 5

Course Objectives:

1. To enable the students to think and appreciate the integrative physiological functioning of the living system
2. To comprehend the role of various hormones in coordinating the activities of biological systems in animals.
3. To empower students to use their conceptual understanding to solve problems.

Unit 1. **Digestive system, Circulatory and Excretory system** — 15hrs

Digestive glands in a mammal –Digestion*,BMR, Blood and Lymph composition, plasma proteins, coagulation and erythropoiesis, blood volume regulation - Heart –myogenic heart, origin and conduction of cardiac impulse-ECG – Endocytosis and exocytosis in excretion -Ultra structure of Nephron – formation and concentration of urine, micturition, Electrolyte and acid base balanc

Unit 2. **Respiratory, Nervous system and Sense organ** — 20hrs

Respiratory pigments-Blood gas transport-Respiratory quotient – Regulation of respiration. Structure and functions of Nervous tissue-Reflex action-Conduction of nerve impulse- Autonomic nervous system, Morphology and physiology of sense organs –vision, hearing, gustation, olfaction and tactile*-

Unit 3. **Skeletal and Muscular system,Communication and Animal behaviour** — 10hrs

Anatomy and physiology of axial and appendicular skeleton- Properties and mechanism of contraction of muscles -Biochemistry of muscles - Neuro muscular junction; Bioluminescence-Pheromones -Biological rhythm-Circadian and Circannual rhythm-Orientation and navigation*

Unit 4. **Endocrine glands** — 15hrs

Anatomy, secretions and functions of endocrine glands in Mammals – Pituitary – hypothalamus-Thyroid-Parathyroid–Pancreas-Adrenal and Prostaglandins* Thermo regulation – comfort zone, body temperature, physical, chemical and neural regulation, acclimatization

Mechanisms of hormone action, Hormone receptor, nuclear receptor, organ receptor, termination of hormone action

Unit 5. **Hormonal Control** — 15hrs

Hormonal regulation of Gastric metabolism: Gadtrin, secretin insulin and glucagon; Hormonal regulation of mineral metabolism: Ca2, PO4, glucose, water, temperature; Reproductive endocrinology: Ovarian cycle, Menstrual cycle and Physiology of pregnancy, Hormonal regulation of male and female reproduction, Neuroendocrine systems in Crustacea and Insecta - Hormone Analogue and its applications*- Genetic disorders due to hormonal imbalance

***Self study**

Total Hours: 75

Text books

1. Rastogi SC. (2007).Essentials of Animal Physiology, New Age International, New Delhi, India.
2. Verma PS. Agarwal VK and Tyagi BS. (2010).Animal Physiology. S. Chand Publishers India

Reference books:

1. Christopher D. and Moyes. (2015).Principles of Animal Physiology. 3rd Edition, Pearson Publishers, U.S.
2. Chatterjee, C.C. Nitin Ashok John, 12th edition, 2018, CC Chatterjee's Human Physiology- CBS Publishers and Distributors PVT.LTD
3. Arora MP. (2017).Animal Physiology. 7th Edition. Himalaya Publishing House, India.
4. Hadley. (2009).Endocrinology. George Bell Publishers, England .
5. Dharmalingam.(2010).Textbook of Endocrinology. Jaypee Medical PU, New Delhi, India.
6. Sherwood L. Klandorf H. and Yancey PH. (2008).Text Book of Animal Physiology. Cengage Learning India Pvt., Ltd.
7. HillR W. Wyse GA. and Anderson M. (2008).Animal Physiology. 2nd Ed., Sinauer Associates, Inc Publisher, Massachusetts.
8. Moyes CD. and Schulte PM. (2007). Principles of Animal Physiology. Pearson Education, Dorling Kindersley Publication. New Delhi.
9. Guyton AC. (2007).Textbook of Medical Physiology. W.B. Saunders Company, Philadelphia, London, Toronto and IgakuShoin/Saunders (Tokyo).

Course Outcomes:

1 The underlining feature of the course is to take an holistic approach, whereby integrating the individual functions of different cells and organs into a whole, the human or animal body.

2 Generate up-to-date knowledge on the interactions and interdependence of physiological and biochemical processes

3 Be able to know the transfer of information from one group of animals to other using signals.

4 Learn generously the life supporting properties and regulation of biological processes in the body from conception through adulthood by the endocrine glands.

5 Understanding of factors influencing the adaptations and responses of organisms to particular environment.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	H	H	H
CO 2	H	H	H	M	H	M	H	H	H
CO 3	H	H	H	H	H	M	H	H	H
CO 4	H	H	H	H	L	L	H	H	H
CO 5	H	M	H	H	H	M	H	H	H

Developmental Biology

Semester II — Hours of instruction / week: 4

25MZOC09 — No of credits: 4

Course Objectives:

1. To understand the basic principles of growth and development
2. To understand the general concept of ontogeny development
3. To understand the metamorphosis and assisted reproductive techniques

Unit 1 **Spermatogenesis and Oogenesis** 15 hrs

Reproduction: a basis of species sustenance. Asexual and sexual reproduction and their relevance in corresponding environments. Origin of primordial germ cells-spermatogenesis process-sertoli cells-spermatogenesis- hormonal regulations, gene expression and control-structure and biochemistry of spermatozoa.Processof Oogenesis – Development during Oogenesis*-Vitellogenesis- egg maturation – egg cortex organization of the egg

Unit 2 **Fertilization, cleavage and Gastrulation** 10 hrs

Mechanism of fertilization – biochemical aspects of cleavage –molecular changes during cleavage – Morphogenesis*: Epiboly, emboly/ invagination, involution and ingression. - cell adhesion molecules and pattern formation. Fate Maps Organogenesis: formation of gut, heart, kidney and muscles.

Unit 3. **Nucleus and cytoplasm in development** 10 hrs

Nuclear control of development - enucleation experiments -
nuclear transplantation* - cytoplasmic determinants – cytoplasmic control of nucleus during development.

Unit 4. **Induction competence and differentiation** 15 hrs

Concept of organizer –embryonic induction – types – properties, role and chemical nature of induction-concept of competence – differentiation of embryonic cells* – stem cells- concept of determination.

Unit 5.: **Metamorphosis, Regeneration and Human development** 10 hrs

Types and hormonal mechanism of metamorphosis in amphibians – regeneration process–histological changes–metaplasia–puberty –menstrual cycle –implantation – parturition –birth defects and surrogacy and ethical laws, Artificial insemination (AI); Gamete intra-fallopian transfer (GIFT). Intra-cytoplasmic sperm injection (ICSI) test tube baby*

*** Self study**

Total Hours: 60

Text Books

1. Balinsky, B. J. 2008. An Introduction to embryology, Saunders Publishers
2. VishramSing, 2020.Text book of Clinical Embryology, 2nd Updated edition, Elsevier India, Elsevier Health Science.
3. Verma, P.S & Agarwal,V.K. 2016 Chordate Embryology (Developmental biology).Generic(1).
4. Morgan. TH. (2010). Embryology and Genetics. Agro House Behind Nasrani Cinema. Fourth edition, Jodhpur, India

5. Veer Bala Rastogi. (2010). Chordate Embryology. KedarNath RamNath publication, New Delhi, India.
6. Brian K, Hall, Benedikt Hall grímsson. Stirickberger's.(2014). Evolution, 5th Edition, Jones and Bartlett India Pvt. Ltd. Publishers.
7. Veer Bala Rastogi. (2014). Organic Evolution, 12th Revised Edition, Kedarnath Ram Nath Publishers, Meerut.

Reference Books

1. Gerhart, J. *et al.* 1997. Cells, Embryos and Evolution. Blackwell Science
2. Baressi,M.J.F and Gilbert, S.F. 2019. Developmental Biology (12th edition).Sinauer Associates is an imprint of Oxford University Press.
3. Wolpert, L. 2015.Principles of Developmental Biology (5th edition). Oxford University Press
4. Campbell, N. and Reece, J. 2014 Biology (10th edition). Benjamin Cummings
5. Scott F. Gilbert, Karen Knisely. (2010.) Developmental Biology- A Student Handbook in Writing in Biology, Third Ed, Sinauer Associates Incorporated, India.
6. Lewis Wolpert (2011). Developmental Biology: A Very Short Introduction. Oxford University Press, First edition.
7. Abhilash Jain. (2010).Advanced developmental Biology. Campus Books International, first edition, New Delhi, India.

Course Outcomes:

1. Develop critical understanding of how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
2. Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
3. Highlights how the processes of development are brought about by changing individual cells into specialized cells with specific functions (the cellular level).
4. comprehend the role of genes within the genome of the organism drive and guide these changes (the molecular level).
5. Developmental biology encompasses the biology of regeneration, asexual reproduction, metamorphosis, and the growth and differentiation of stem cells in the adult organism.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	H	L	L	H	L	H
CO 2	H	L	H	L	L	L	H	L	H
CO 3	H	L	H	L	M	L	H	M	H
CO 4	H	H	H	H	H	L	H	H	H
CO 5	H	H	H	H	H	L	H	H	H

Evolution

Semester II — Hours of instruction / week: 4

25MZOC10 — No of credits : 4

Course objectives

1. To understand the basic principles of Evolution
2. To know about the origin of life and theories of Evolution
3. To learn about the natural selection, genetic variation and behavioural evolution

Unit 1. **Origin of life and evolutionary concept** — 12hrs

Concept and evidence of evolution-morphology, comparative, embryology and paleontology anatomy. Theories of Evolution- Lamarkism, Darwinism, Devries mutation theory and Modern theory. Origin of life – Oparin theory, Prebiotic synthesis and Biological evolution-origin of coacervates, Protocells. Mendelism; Spontaneity of mutations.

Unit 2. **Mechanism of Evolution** — 12hrs

Variation- Types of variation-Isolation- Premating and Post mating mechanism - Hardy Weinberg's law of equilibrium and significance - Natural selection; Molecular evolution and phylogenetics: Concepts of neutral evolution, molecular divergence - Molecular tools in phylogeny - Evolution of Protein; Molecular clocks; rates of evolution; Species concepts and speciation; phylogenetic tree construction.

Unit 3. **Consequences of Evolution** — 12hrs

Adaptation – Types of adaptation, Divergent and Convergent of Evolution, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution. Mimicry- protection, aggressive and conscious mimicry, Protective coloration- *Biological significance of colours.

Unit 4. **Paleontology and Behavioral evolution** — 12hrs

Paleontology-Classification of rocks-Fossils- Types, Formation, dating and significance. Geological time scale- Eras- Periods – Epoch. Behavioral evolution-Proximate and ultimate causation; *Group selection, Altruism, Reciprocal altruism, Kin selection and Sexual selection

Unit 5. **Human evolution and Philosophical issues** — 12hrs

History of primates, Stages in primate evolution including Homo, significant stages in evolution of man, Comparison between humans and other primates – Fossil and Genetic evidence of origin of modern man.*Cultural evolution and Evolutionary future of mankind.

***Self study**

Total Hours: 60

Text Books:

1. Jonathan Bard (2022) Evolution: The Origins and Mechanisms of Diversity, Taylor and Francis Group
   Brian K, Hall, Benedikt Hall grímsson. Stirickberger's.(2014). Evolution, 5th Edition, Jones and Bartlett India Pvt. Ltd. Publishers.
2. Veer BalaRastogi. (2014). Organic Evolution, 12th Revised Edition, Kedarnath Ram Nath Publishers, Meerut.
3. Rao CV.(2005). Human evolution and its uniqueness, Atlantic Publishers and distributors,
   New Delhi.
4. Verma PS, Agarwal VK. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Second Edition, S. Chand Company Ltd, New Delhi.
5. Charles Darwin, 2021. The Origin of Species. (1 may Deluxe Hard bound 2021edition finger print publishing.

Reference Books:

1. Franklin Shull A. (2008).Evolution, Second Edition, J.V.Publishing House, Jodhpur.
2. Mark Ridley. (2004). Evolution, Third edition, Blackwell Science Ltd , USA.
3. Gould SJ. (2002). The structure of evolutionary theory. Harvard University Press, Cambridge.
4. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.2007. *Evolution*. Cold Spring, Harbour Laboratory Press.

Course Outcomes:

1. Understand the contemporary observations of biological evolution
2. Knowledge and skills in Phylogenetic analysis related to molecular evolution.
3. Analyze the role of pattern, adaptive features of consequences of evolution.
4. Acquire evolutionary information of the fossil record
5. Investigate the evolutionary basis of behavior in primates and man.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	H	H	H	M	H
CO 2	H	H	H	H	H	M	H	M	H
CO 3	H	H	H	H	H	M	H	M	H
CO 4	H	H	H	M	H	H	H	M	H
CO 5	H	H	H	M	H	M	H	M	H

Practicals III –Biochemistry, Biophysics, Animal Physiology, Endocrinology, Developmental Biology and Evolution

Semester II — Hours of instruction / week: 6

25MZOC11 — No of credits: 3

Course Objectives:

1. Able to demonstrate the fundamental principles of chemistry and physics in biology.
2. To understand the general concept of endocrine glands.
3. To understand the basics of developmental and evolutionary biology

Biochemistry and Biophysics

1.	Estimation of protein in fish sample	5 hrs
2.	Estimation of carbohydrates in fish sample	5 hrs
3.	Estimation of amino acid by Ninhydrin method.	5 hrs
4.	Salivary amylase activity in relation to pH	3 hrs
5.	Separation of amino acids using paper and thin layer chromatography	4 hrs
6.	Preparation of phosphate buffer saline (PBS buffer, pH - 8) and tris-buffered saline (TBS, pH – 7.4)	3 hrs

Animal Physiology and Endocrinology

1.	Estimation of Hemoglobin	3 hrs
2.	Preparation of haemin crystals	3 hrs
3.	Enumeration of RBC and WBC using haemocytometer	3 hrs
4.	Calculation of BMI in human.	2 hrs
5.	Effect of temperature on breathing rate in frog (Virtual)	2 hrs
6.	Effect of various drug on heart rate in frog (Virtual)	2 hrs
7.	Study of nitrogenous waste products of animals from different habitats.	5 hrs
8.	Effect of salinity on the metabolic rate of fish	3 hrs
9.	Estimation of chloride content of fish	4 hrs
10.	Effect of thyroxine on the oxygen consumption fish	4 hrs
11.	Study of capillary circulation among students (virtual)	2 hrs
12.	Examine the electrical activity of skeletal muscle (virtual)	2 hrs

Developmental Biology and Evolution

1.	Slides on Frog Embryology - T.S. of ovary, Cleavage - 2 cell, 4 cell, 8 cell and 32 cell stages; Blastula - Gastrula – Yolk plug stage, Neural plate, Neural fold Neural tube; Tadpole – 4mm, 7mm, 10mm	3 hrs
2.	Observe the developmental stages in chick egg at different hours of incubation	6 hrs
3.	Slides on chick embryology - Chick embryo - 18h, 24h, 36h, 48h, 72h, 96h and 120h	2 hrs
4.	Slides on the structure of human sperm and ovum	2 hrs

5. Connecting links - Neopilina, Balanoglossus, Chimaera, Archaeopteryx - Virtual aids — 2 hrs
6. Fossil specimens - Limulus, Peripatus, Nautilus, Brachiopod, Gastropod, Trilobites — 3 hrs
7. Selection representing adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution) using virtual aids. — 3 hrs
8. Study of homology and analogy from suitable specimens/ virtual aids — 3 hrs
9. Field visit to Fossil Museum Ariyalur — 6 hrs

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination.

Total Hours: 90

Course Outcomes:

1 Assess the estimation of protein, carbohydrate and fat using fundamental biochemical principles together with biophysical instruments.
2 Estimation of different physiological systems and their specific functions.
3 Identify the developmental stages of organisms and its evolutionary significance.
4 Recognize the homology in the development of embryos.
5 Acquire information on evolutionary significance in modern era of life.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	M	L	H	H	H
CO 2	H	H	H	M	M	L	H	H	H
CO 3	H	H	H	M	L	L	H	H	H
CO 4	H	M	H	M	L	L	H	H	H
CO 5	H	H	H	H	H	H	H	H	H

Biostatistics and Bioinformatics

Semester III — Hours of instruction / week: 4

25MZOC12 — No of credits: 4

Course objectives:

1. To learn the methods of data collection and the application of statistical methods in solving biological problems
2. To know the principles of research design and thesis writing
3. To develop the technical art of writing research report and presentations.

Unit 1: **Introduction to Statistics** — 12 hrs

Statistics –Scope, limitations and applications - Secondary data- Sources of statistical data- Classification and Tabulation of data-*Diagrammatic representation -line diagram, bar diagrams, pie diagram, pictogram, cartogram, and Graphical representation of statistical data – line graph, histogram, frequency polygon, frequency curve and Ogive curve.

Unit 2: **Descriptive statistics** — 12 hrs

Attributes and Variables- Measures of central tendency – types - merits and demerits. Measures of dispersion – *objectives, range, quartile deviation, mean deviation, standard deviation.

Correlation and regression analysis - Definition, uses, types and methods – scatter diagram, graphic method, Karl Pearson's coefficient of correlation - Regression lines- Regression equations andRegression coefficients.

Unit 3: **Sampling and Theoretical Distribution** — 12 hrs

Sampling – meaning, advantages, Concept of parametric and Non-parametric statistics- *Introduction of Probability and its applications-Types of samples-Theoretical distributions-Types-Samplingdistribution- Properties and applications

Testing of Hypothesis

Testing hypothesis-Null hypothesis, alternative hypothesis, - Confidence interval -Levels of significance -Degrees of freedom-Student's t- test-Analysis of variance - One way and Two-way classification- Non-parametric-chi-square test,Kruskal Wallis Test-Multivariate analysis

Unit 4: **Biological databases** — 12 hrs

Introduction to Bioinformatics: Definition - goals – applications; Central Bioinformatics Resources and Access Information: NCBI - EMBL-EBI; **Biological databases**: Nucleotide sequence database (GenBank, EMBL-Bank, DDBJ) - Protein database (UniProtKB, PIR, PDB, InterPro, Pfam, PRINTS, SCOP and CATH) - Specialised database (OMIM, GEO, ENA, KEGG, and PubMed);Biodiversity and ecosystem based databases.**Sequence format**: GenBank format - Applications of bioinformatics.

Unit 5: **Sequence analysis, Genomics and proteomics** 12hrs

Pairwise sequence Alignment methods: Global and Local alignment – FASTA and BLAST; **Multiple sequence alignment and Phylogeny: -** CLUSTALW – phylogenetic tree building-**Genomics:**Finding genes in genome (GENCODE) – SNPs - **Next Generation Sequencing**: Overview of Techniques - Data analysis - Applications **Proteomics: Seondary structure prediction-:Ramachandran Plot,**JPred and PSIPRED-**Tertiary structure prediction** :Homology modelling – Threading – *Ab Initio* prediction – structure validation – structure visualization tools;RASMOL, Application in Modern drug discovery process

***Self study**

Total Hours: 60

Textbooks:

1.Gupta, S,P.(2004). Statistical methods, Sultan Chand and Sons Publishers, New Delhi.

2. Gurumani,N.(2021). An Introduction of Biostatistics, MJP publishers, Chennai

3.Rastogi SC, Rastogi P, Mendiratta N. (2022). Bioinformatics Methods and Applications: Genomics Proteomics and Drug Discovery, 5thEdn, PHI Learning Pvt. Ltd.

4. Xiong J. (2012). Essential Bioinformatics, Cambridge University Press

References Books:

1.Sokal and Rohlf(1969).Introduction to Biostatistics, Dover Publications, Micola, New York.

2.Norman T.J. Bailey (1995)Statistical methods in biology(Third Edition)Cambridge University Press,Cambridge.

3.Klaynekl Daniel.(2009). Biostatistics, Wiley India Pvt. Ltd., New Delhi

4.Ronald, N. Forthofer, EunSulLee.(2010). Introduction to Biostatistics, Elsevier Publications India Pvt. Ltd, New Delhi

5.Richard S L, Tudor I O. (2019).Bioinformatics and Drug Discovery- Methods in Molecular Biology, 3rdEdn, Springer New York

6. Pevsner J. (2019).Bioinformatics and functional genomics, 3rdedn, Wiley India exclusive

7. Chandarsekar M, Ratankumar C, Mirasif I. (2018). Basic applied bioinformatics, Ist Edn., John Wiley& sons

Course Outcomes:

1.Understand the basic concepts and applications of biostatistics.

2.Calculate the descriptive statistics and its significance.

3.Knowledge on implementation of hypothesis in validating a model.

4.Locate and use the main databases at the NCBI and EBI resources and know the difference between databases, tools, repositories and be able to use each one to extract specific information

5.Able to perform simple genome sequence analyses using existing tools and predict secondary and tertiary structures

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	L	M	L	H	M	L
CO 2	H	M	H	L	M	L	H	M	L
CO 3	M	H	M	H	H	M	M	H	M
CO 4	H	H	M	L	H	L	M	H	-
CO 5	H	H	H	M	H	L	H	M	M

Microbiology and Biotechnology

Semester III — Hours of instruction / week: 3

25MZOC13 — No of credits: 3

Course objectives:

1. To enable the student to learn on recent advances in Microbiology and Biotechnology
2. To understand the appliations of microbes in various sectors
3. To develop practical knowledge and acquire analytical skills.

Unit 1 **Microbial Taxonomy and Methods in Microbiology** — 9 hrs

Structure and outline classification of Bacteria, Fungi and Virus. Sterilization techniques - Physical and Chemical, Culture media – Types and Preparation, Process of sample collection, Methods of growing microbes, Cultivation of aerobes – Batch and continuous culture - Turbidostat and Chemostat, Synchronous culture, Anaerobes- Gas Pack method, Methods of isolation and maintenance of pure culture, Identification of bacteria, Nutritional requirements for microbes, Growth curve of microbe*, Factors affecting microbial growth, Measurements of microbial growth

Unit 2 **Industrial and Environmental Microbiology** — 9 hrs

Industrial Microbiology: Bioprocessing, Fermentors- Types, Functions, Design and Operation, Microbial selection, Types of Fermentation- Submerged, Solid and Surface type, **Stages in fermentation** - Upstream and Downstream Processing. Fermented products- Single Cell Protein, Wine, Citric acid, Vitamin B_{12}

Environmental Microbiology: Bioremediation - Criteria for bioremediation, Bioremediation techniques, Types of biosorbents, Methods for removal of pollutants, Mechanism of biosorption, Factors affecting biosorption, Desorption and recovery, Advantages and disadvantages, Large scale industrial effluent treatment, Bioindicators*

Unit 3 **Molecular tools in genetic engineering** — 9 hrs

Enzymes in genetic engineering: Basic steps of gene cloning, DNA manipulative enzymes. Exonucleases, Endonucleases, Restriction Endonuclease and its types*, S1 Nuclease, DNA ligase, Alkaline phosphatase, Reverse transcriptase, DNA Polymerase Methyl transferase, Polynucleotide kinase, Terminal transferase

Vectors in gene cloning: Cloning vehicles, Plasmids, Bacteriophages, Cosmids, Phagemids, Yeast artificial chromosomes, Bacterial artificial chromosomes, expression vectors, shuttle vectors.

Unit 4 **Gene transfer and recombinant techniques** — 9 hrs

Methods of gene transfer: Transformation, conjugation, electroporation, microinjection, direct gene transfer, agroinfection, liposome fusion, biolistics. Gene cloning strategies*

Identification of recombinants : Restriction enzyme analysis, Blotting Techniques, DNA Sequencing, PCR - Primer-design and Reverse transcription PCR. DNA Probes, RFLP, RAPD*, Genomic library, cDNA library, Gene silencing.

Unit 5 **Animal Biotechnology**- Facilities for animal cell culture – Sterilization - Culture media for animal cells, Biology and characterisation of cultured cells, Cell synchronization, Measurement of senescence and apoptosis, Primary cell culture – Techniques for primary cell culture – Cell lines and its types – Subculture and its types-Applications of animal tissue culture. Cryopreservation, Gene therapy, Stem cell and microRNA therapy. 9 hrs

Total hours: 45

Text Books:

1.Chess B. and Talaro KP (2024).Talaro's Foundations in Microbiology, 12th Edition, Mc-Graw – Hill Publishing Company Ltd., New Delhi .

2.Willey J, Sherwood L, Woolverton CJ, (2023). Prescott's Microbiology, 12th Edition, Mc-Graw – Hill Publishing Company Ltd., New Delhi.

3.Sobti RC, Suparrna S. Pachauri. (2009). Essentials of Biotechnology, 1st Edition. Ane Books Pvt. Ltd, Chennai, New Delhi, Mumbai

4.Dubey RC. (2006). A textbook of Biotechnology, S.Chand and Company Ltd., New Delhi.

5.Satyanarayan,U and Chakrapani.U (2010). Biotechnology, 2nd Edition, Arunabha Sen Publisher, Kolkata.

Reference Books:

1. Micheal J, Pelzar JR, Chan ECS, Krieg NR (2009). Microbiology, 10th Edition, Tata Mc-Graw–Hill Publishing Company Ltd., New Delhi.

2. Casida, J.R. (2022). Industrial Microbiology, 2nd Edition, New Age International Publishers, New York.

3. Glick BR, Pasternak JJ, Patten CL. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA, Fourth Edition, ASM Press, Canada

4. V.A Saunders (2012). Microbial Genetics Applied to Biotechnology: Principles and Techniques of Gene Transfer and Manipulation. Springer Science and Business Media.

5. Mathews and Mickee (2015). An introduction to genetic engineering in plants, Blackwell Scientific Publishers. London.

Course Outcomes:

1. Apply culture techniques in clinical and research problems
2. Describe the importance of microbes in industrial and environmental sectors
3. Understand the tools and techniques in rDNA technology and its applications
4. Provide the ability to decipher, evaluate and understand data generated from biotechnology-based assays
5. Comprehend fundamental concepts and principles of establishing animal cell culture

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	M	M	M	H	L	H	M	H
CO2	H	M	M	H	L	H	H	M	H
CO3	M	H	M	H	M	L	H	M	H
CO4	H	M	H	H	H	L	H	M	H
CO5	H	M	H	H	H	H	H	M	H

Immunology

Semester III — Hours of instruction / week :4

25MZOC14 — No of credits:4

Course objectives:

1. To outline the key components of the innate and adaptive immune responses
2. Define the cellular/ molecular pathways of humoral /cell-mediated immune response
3. Be able to acquaint with immune system of our body

Unit 1. **Innate and adaptive immune system:** Types of immunity-Innate and Acquired immunity, Ultra structure and functions of primary and secondary lymphoid organs, Cells and molecules involved in innate and adaptive immunity origin and differentiation of B and T cell. — 12 hrs

Unit 2 **Antigens and Immunogens:** — 12 hrs

Antigens:.3D structure-classes- antigenic determinants- B and T cell epitopes, Antigenicity and immunogenicity. **Immunoglobulins**: Structure and function of antibody molecules, Generation of antibody diversity, class switching, monoclonal antibodies, antibody engineering, **Antigen-antibody interactions**: affinity, avidity, cross reactivity, precipitation and agglutination reaction, radio immuno assay, ELISA, immuno fluorescence. Application of Immunological techniques in disease diagnosis. Tracer techniques: Principle and Applications

Unit 3 **Immune response:** — 12 hrs

Major Histocompatibility Complex: structure of MHC molecules – types- antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell mediated immune responses, primary and secondary immune modulation

Unit 4 **Complements and Hypersensitivity** — 12 hrs

The complement system: classical and alternative pathways and immunological significance , Toll-like receptors, cell-mediated effector functions, inflammation, **Hypersensitivity reaction**- type 1, type 2, type 3 and type 4 reactions, immuno deficiency diseases, Immunological tolerance

Unit 5 **Transplantation and tumour immunology** — 12 hrs

Transplantation immunology: HLA typing-immunology of graft rejection- immuno suppressive therapy, **Tumour immunology**- tumour antigen, immunity against cancer, cancer immuno therapy, **Auto immunity**- organ specific and systemic auto immune diseases, immune response during with track changes bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immune deficiencies, vaccines

Total hours - 60

Text Books:

1. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen. (2023). *Kuby Immunology,* 8th Edn., Macmillan, London
2. Richard Coico. (2021). *Immunology: A Short Course*, 8th Edition., Wiley-Blackwell, New Jersey
3. Seamus J. Martin, Dennis R. Burton , Ivan M. Roitt, Peter J. Delves. (2017). *Roitt's Essential Immunology*, John Wiley, New Jersey

Reference Books:

1. Male D. (2020). *Immunology*, 9th Edn., Elsevier, Philadelphia
2. Abbas AK, Lichtman AH, Pillai S. (2021). *Cellular and Molecular Immunology*, 10th Edn., Elsevier, Philadelphia
3. Kindt TJ, Goldsby RA, Osborne BA. (2018). *Kuby Immunology*, 8th Edn., W.H. Freeman, New York
4. Delves PJ, Martin SJ, Burton DR, Roitt IM. (2017). *Roitt's Essential Immunology*, 14th Edn., Wiley-Blackwell, Hoboken
5. Sriskandarajah P. (2025). *Crash Course Haematology and Immunology*, 5th Edn., Elsevier, Philadelphia
6. Murphy K, Weaver C. (2022). *Janeway's Immunobiology*, 10th Edn., Garland Science, New York
7. Goering R, Dockrell HM, Zuckerman M, Chiodini PL. (2025). *Mims' Medical Microbiology and Immunology, International Edition*, 7th Edn., Elsevier, Philadelphia. ISBN: 9780443107474
8. Surinder Kumar. (2012). *Textbook of Microbiology*, Jaypee Brothers Medical Publishers, New Delhi. ISBN : 978-93-5025-510-0

Course outcomes

1. Describe the cell types and organs that are involved in immune response
2. Apply immunological techniques to solve certain clinical and research problems
3. Explain functions of these cellular and molecular components during immune response
4. Able to differentiate between various types of hypersensitivity reactions
5. Identify the main mechanisms of immune tolerance and autoimmunity

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	H	L	H	H	H
CO 2	M	H	M	H	M	M	M	H	H
CO 3	M	M	H	H	H	L	H	M	M
CO 4	H	L	M	M	H	L	M	M	M
CO 5	L	L	L	L	M	L	H	H	H

Environmental Biology

Semester III | Hours of Instruction / week: 3
25MZOC15 | No of credits: 3

Course objectives:

1. To understand the various factors of environment
2. To learn about the implications of environment on human health and social issues
3. To have knowledge about environmental toxicants and their hazards

Unit 1	**Ecological Principles and Ecosystem** Ecosystem structure - Physical and biotic environment, biotic and abiotic interactions, Ecosystem function, energy flow and mineral cycling (C,N,P), primary production and decomposition, structure, functions and adaptations of terrestrial (forest, grassland, desert) and aquatic (fresh water, marine, eustarine, mangrove) ecosystems.	7 hrs
Unit 2	**Community Ecology** Habitat and Niche - Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement. Community Ecology - Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones. Ecological Succession – Types, mechanisms, changes involved in succession, concept of climax. Keystone species	7 hrs
Unit 3	**Population Ecology and Species Interactions** Population Ecology- Characteristics of a population, population growth curves, population regulation, life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions - Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis	11 hrs
Unit 4	**Environmental toxicology** Types of environmental toxicants – pesticides, automobile emissions, heavy metals, fertilizers, food additives, radioactive substances, teratogens, carcinogens and mutagens. Accumulation of toxic residues in organisms-routes of entry, absorption, distribution, excretion. Biotransformation of toxicants, mode of action. Classification and assessment of toxicity - acute and chronic toxicity - LC_{50} and LD_{50} assessment - dose response relationship. Molecular mechanism of toxicant action - biomagnification - bioaccumulation of toxic use, risk assessment and safety evaluation of toxicants.	11 hrs
Unit 5	**Biodiversity Conservation and Environmental Policies** Biodiversity – Importance, Biogeographical zones of India, Hotspots in India, Levels of biodiversity, Diversity indices – Shannon, Simpson and Fisher's Alpha, Measures of biodiversity, IUCN Red list Categories,	9 hrs

Factors responsible for biodiversity extinction, Measures to conserve biodiversity (In situ and Ex situ conservation), Wildlife conservation projects – project tiger - project elephant - crocodile conservation - crocodile breeding project, operation rhino, Gir lion project, white rumped vulture - Goi-UNDP sea turtle project, AI interventions in protection of biodiversity.

Environmental movements – Silent Valley, Chipko, Narmada Bachao Andolan, National test range at Baliapal movements. National and International Policies for Environmental Protection

Total Hours: 45

Text Books:

1. Sharma PD. 2018. Ecology and Environment. 13th Edition, Rastogi Publications, Uttar Pradesh.
2. Krishnamurthy KV. 2018. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford & IBH Publishing Co Pvt. Ltd.
3. Raman Sivakumar. (2010). Environmental Science & Engineering. Tata McGraw Hill Education Private Ltd

Reference books:

1. Primack RB. (2010). Essentials of Conservation Biology. Sinauer Associates: USA
2. Mittermeier RA, Meyers PR, Gil and. Mittermeier CG. (2000). Hotspots: Earth's biologically richest and most endangered Terrestrial Ecoregions. Cemex /Conservation International USA
3. Matthew RF. 2021 Environmental Biology. Open Oregon Educational Resources.

Course outcomes:

1. Learn about the complexity of natural resources and understand the conservation strategies of biodiversity
2. Reflect critically on their roles, responsibilities and identities as citizens, consumers and environmental actors in a complex interconnected world.
3. Develop a critical understanding of the social environment and Indian constitutional provisions concerning environmental protection.
4. Demonstrate the core concept of toxicology and identify the contemporary issues in toxicology
5. Appreciate the ethical, cross-cultural and historical context of environmental issues and application of ecological and physical sciences in environmental problem solving.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	H	M	H
CO 2	H	H	H	H	H	H	H	M	H
CO 3	M	H	H	H	H	H	H	M	H
CO 4	H	H	H	H	H	H	H	M	H
CO 5	H	H	H	H	H	H	H	H	H

Practicals IV- Bioinformatics, Microbiology, Biotechnology, Immunology and Environmental Biology

Semester III
25MZOC16

Hours of instruction / week: 6
No of credits: 3

Course objectives:

1. To understand the application of immunology and bioinformatic tools.
2. To enable the students to know the biochemical aspects of microbes and molecular based techniques
3. To understand the basics of environmental biology

Bioinformatics

1	Search engines and important sites viz., NCBI, EBI, Swiss-Prot	2 Hrs
2	Format, distinguishing features, Uses and Applications of biological databases such viz., EMBL, DDBJ, GenBank,UniProt, PIR, TrEMBL, Prosite, PRINT, Pfam, BLOCK,PDB, KEGG,OMIM,PUBMED	2 Hrs
3	Use of BLAST and its variants (especially PSI-BLAST) for the identification of very similar and divergent sequences	2 Hrs
4	Multiple sequence alignment using Clustal W and preparation of simple phylogenetic trees using Tree View	2 Hrs
5	Detection of general signals, regulatory regions and promoter prediction	2 Hrs
6	Secondary structure prediction using various available tools	2 Hrs
7	Tertiary structure and function prediction using homology modeling and ab initio method	2 Hrs
8	Visualization of 3D protein structure –Rasmol-Swiss PDB viewer	2 Hrs

Microbiology

9	Methods of growing microbes –Agar, Broth, Slant, Stab culture	3 Hrs
10	Isolation and enumeration of bacteria and fungi from soil, water (Spread and pour plate methods) and air (open plate method)	6 Hrs
11	Streak Plate Methods – Quadrant Streaking, T-Streaking, Continuous Streaking and Radiant Streaking	3 Hrs
12	Identification of bacteria by Gram and Negative staining	3Hrs
13	Motility of bacteria by hanging drop method	2Hrs
14	Biochemical tests – Indole, Methyl red, Voges Proskauer, Citrate Utilization, Catalase, Carbohydrate fermentation test and Starch hydrolysis tests	3Hrs
15	Identification of fungi by lacto phenol cotton blue staining	3Hrs
16	Determination of Microbial growth – Turbidity method	3Hrs
17	Effect of environmental factors (pH, temperature, incubation time and carbon sources) on microbial growth	3Hrs
18	Production of Wine	3Hrs
19	Bioremediation of industrial effluent/ sewage water using biosorbents	3Hrs
20	Determination of coliforms in water sample through MPN technique	3Hrs
21	Spotters – Inoculation loop, Autoclave, Incubator, Hot air oven, Nutrient agar medium, Rose Bengal Chloramphenicol agar medium, Muller Hinton agar medium	2Hrs

Biotechnology

22	Isolation and estimation of DNA from goat liver	3Hrs
23	Separation of DNA using agarose gel electrophoresis	3Hrs
24	Polymerase Chain Reaction for amplification of DNA (Demonstration)	3Hrs
25	Media Preparation for Animal Cell Culture	3Hrs

Immunology

26	Blood grouping and haemagglutination	3Hrs
27	Widal test – Kit method	2Hrs
28	Single radial Immunodiffusion technique	3Hrs
29	Enzyme Linked Immunosorbent Assay - Demonstration	2Hrs

Environmental Biology

30	Study the taxonomic diversity in a given habitat by quadrat method	3Hrs
31	Study the chemical characteristics (pH, EC, moisture, carbonate and nitrate content)	3Hrs
32	Study the behavioural response of a fish under stress conditions	3Hrs
33	Determination of LC_{50} and LD_{50} of a toxicant for the selected fish under laboratory conditions	3Hrs

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

Total Hours: 90

Course Outcomes:

1. Apply bioinformatics tools to analyse the biological data
2. Able to identify microbes and assess its impact on environment
3. Recognize the impact of xenobiotics on environment
4. Gain knowledge on immunological techniques
5. Apply biotechnological methods in research sectors

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	H	M	L	M	M	L	H	M	H
CO2	H	H	M	M	H	H	M	L	H
CO3	M	L	L	H	M	L	H	M	H
CO4	H	M	H	H	H	H	H	M	H
CO5	H	M	H	H	H	H	H	M	H

Entrepreneurial Avenues in Zoology
(Self Study Course)

Semester III — Hours of instruction/week: 2

25MZOC18 — No of credits: 2

Course objectives:

1. To disseminate information on economic aspects of Zoology
2. To inculcate knowledge on useful animals to man kind
3. To understand the modern techniques of animal culture

Unit 1 **Apiculture** — 7hrs

Life cycle of honey bee, kinds of honey bees- Difference between Natural and artificial hives – polymorphism and its importance. Diseases and Enemies - preventive measures and control. Role of National Bee Board (NBB) - Central Bee Research and Training Institute (CBRTI) honeybee products – honey -pollen -royal jelly -bees wax - propolis and bee venom and its uses

Unit 2 **Sericulture** — 7 hrs

Life cycle and rearing of silkworm moth (*Bombyxmori*), Silkworm rearing technology: Types of mountages Spinning - harvesting and storage of cocoons. Diseases- Protozoan, bacterial, fungal & viral- setting up of a sericulture unit. National Sericulture Project (NSP) – overview - Silk examination - cleaning - lacing - bookmarking and grading of silk.

Unit 3 **Pisciculture** — 6 hrs

Cultivable species of fishes in India - culture of freshwater prawns – polyculture- Shrimp and fish hatchery and farm management. Cage and pen culture practices in India. Fish diseases: Bacterial- viral –fungal- parasitic. Export of fishery products from India and major countries - important products

Unit 4 **Vermiculture** — 5 hrs

Cultivable species of earthworm – vermi composting methods - earthworms as bioreactor – conditions required for vermicomposting – vermicast – vermiwash. Small Scale Earthworm farming - Conventional commercial composting - Earthworm Farming (Vermiculture) - vermicomposting harvest and processing.

Unit 5 **Poultry Science** — 5 hrs

Breeds of fowls – the deep litter system – practical aspects of chick rearing – management of growers and layers – feed formulations –Diseases-management vaccines. Nutritive value of egg - factors affecting egg size - storage and preservation of egg – marketing of egg and meat

Total Hours: 30

Text Books:

1. Supriti Sarkar, Kuntu, chaki. Introduction to Economic Zoology. New Central Book Agency 2014
2. Manju Yadav. Economic Zoology. Discovery Publishing House, New Delhi 2013

Reference Books:

1. Shivanand M Gotyal. Economic Zoology. Iterative International Publishers 2024
2. Ahsan,Jawaid Sinha, Subhas Prasad. A Handbook of Economic Zoology. S. Chand and Copany Ltd 2023.
3. Shukla,Upadhyay. Economic Zoology. Rastogi Publications 2021
4. Sheikh, MS. Apiculture. Global NET Publishers 2023

Course outcomes:

1. Apply the knowledge of managing beehives for honey production and marketing
2. Acquire knowledge about the rearing of silkworms and causative agents of silkworm diseases.
3. Understand various methods of aquaculture practices.
4. Role of vermiculture in protecting the environment and managing the waste
5. Describe poultry breeds and basic concepts related to vaccines and marketing.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	M	H	H	H	H	H
CO 2	H	H	M	M	H	H	H	H	H
CO 3	H	H	M	L	H	H	H	H	H
CO 4	H	H	M	L	H	H	H	H	H
CO 5	H	H	M	M	H	H	H	H	H

Sustainability course
Economic Entomology

Semester III — Hours of Instruction/week : 2+3

25MZOSC1

Course Objectives:

1. To understand the taxonomy, classification and life cycle of insects.
2. To know the beneficial and harmful insects in animals and human.
3. To gain knowledge about insect pests, epidemiology of vectors and its control measures.

Unit 1. Introduction to Insect Classification — 15 hrs

Overview of insects and insect taxonomy: Insect morphology, anatomy and physiology. Insect metamorphosis and hormones. Insects - life cycle & development – Insect behavior and ecology.

Practical 1: Identification and documentation of common insects.

Practical 2: Various collection methods of insects – pitfall, Berlese funnel, Malaise trap, light trap, bait trap.

Unit 2. Beneficial insects — 15 hrs

Silkworms - types, life history, disease management and rearing methods - Types of honey bees, life history, social organization and management of bee hive - Lac insects - life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil-builders.

Practical 3: Dry and wet preservation of insects.

Practical 4: Rearing of various insects.

Unit 3. Destructive insects — 15 hrs

Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Pests of paddy, cotton, sugarcane, vegetables, coconut and other stored grain pests.

Practical 5: Study of lifecycle of hemimetabolous, holometabolous and ametabolous insects (one example each).

Practical 6: Preparation of insect box.

Unit 4. Vectors and vector borne diseases — 15 hrs

Vectors of veterinary and public health importance –Sand files, Bugs – Human bugs, lice & fleas. Life cycle of Housefly, Cockroach and Mosquito– Epidemiology and management of Malaria, Dengue and Filariasis.

Practical 7: Mounting of mouth parts of various vectors (Housefly, Cockroach and Mosquito)

Practical 8: Preparation of permanent slide using insects and its parts.

Unit 5. Pest and vector management — 15 hrs

Methods and principles of pest control - Natural control, Artificial control– Integrated Pest Management - Concepts and practice. Integrated vector control program. Chemical, Physical and Botanical control.

Practical 9: Pheromones control, repellent activity, and various trapping method for pest control

Practical 10: Case studies on the management of vector/pest control.

Total hours: 75

Text Books:

1. Kamal Saini, 2024. A Text Book of Applied Entomology (First Edition). AG Publishing House. New Delhi, pp- 528.
2. Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.
3. Vasanthara David, B., and Kumaraswamy, T. (1982). Element of Economic Entomology. Popular Book Depot, Madras.

Reference Books :

1. Chapman, R.F., S.J. SimpsonandA.E.Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2. Imms, A.D., O.W.Richards and R.G. Davies (Eds.), 2013 IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.
3. B.F. Eldridge, J.D. Edman, 2003. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods. Springer.
4. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. Mc Graw-Hill Kogakusha Ltd., Tokyo, pp-564.
5. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.
6. Krishnaswami, S. 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
7. Choudhary, V. (2008). Entomology and Part Management. Navayag Publishers, New Delhi.
8. *Larry*P.*Pedigo*, Marlin E. Rice. (2009) Entomology and Pest Management, 6th edition. Prentice-Hall, New Jersey.

Course Outcomes:

1. Understand taxonomy, classification and life of insects in the animal kingdom.
2. Know the life cycle, rearing and management of diseases of beneficial insects.
3. Gain knowledge about monitoring insect pests and control measures.
4. Recognize insects which act as vectors causing diseases in animals and human.
5. Students can predict vector-borne diseases and its prevalence and management.