

406 - M.Sc. ZOOLOGY

Programme Structure and Scheme of Examination (Under CBCS) for affiliated Colleges
 Applicable to the Candidates admitted from
 the academic year 2022-2023 onwards

Course Code	Study Components & Course Title	Hours / Week	Credits	Maximum Marks		
				CIA	ESE	TOTAL
SEMESTER - I						
22PZOOC11	Core Course I: Structure and functions of Invertebrate and Vertebrate	4	3	25	75	100
22PZOOC12	Core Course II: Developmental Biology	4	3	25	75	100
22PZOOC13	Core Course III: Cell and Molecular Biology	4	3	25	75	100
22PZOOP14	Core Practical - I: Course Covering 22PZOOC11,12 & 13	12	6	40	60	100
22PZOOE15	Core Elective - I	3	3	25	75	100
22PZOOO16	Open Elective - I	3	3	25	75	100
Total		30	21			600
SEMESTER - II						
22PZOOC21	Core Course IV: Animal Physiology	4	3	25	75	100
22PZOOC22	Core Course V: Genetics	4	3	25	75	100
22PZOOC23	Core Course VI: Biochemistry	4	3	25	75	100
22PZOOP24	Core Practical - II: Course Covering 22PZOOC21, 22 & 23	12	6	40	60	100
22PZOOE25	Core Elective - II	4	4	25	75	100
22PHUMR27	Compulsory Course: Human Right	2	2	25	75	100
Total		30	21			600

List of Core Elective (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	H / W	Credits	CIA	ESE	TOTAL
I	22ZOOE15-1	Toxicology	4	4	25	75	100
	22ZOOE15-2	Apiculture	4	4	25	75	100
	22ZOOE15-3	Public Health and Hygiene	4	4	25	75	100
II	22ZOOE25-1	Entomology	4	4	25	75	100
	22ZOOE25-2	Biophysics & Biostatistics	4	4	25	75	100
	22ZOOE25-3	Vermitechnology	4	4	25	75	100

List of Open Elective (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	H/W	Credits	CIA	ESE	TOTAL
I	22ZOOO16-1	Vector Biology and Vector Borne Diseases	3	3	25	75	100
	22ZOOO16-2	Poultry Farming and Management	3	3	25	75	100
	22ZOOO16-3	Waste Management	3	3	25	75	100

Semester- I	22PZOOC11: STRUCTURE AND FUNCTIONS OF INVERTEBRATES AND VERTEBRATES	CREDITS: 3 HOURS: 4
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COURSE Objectives

- 1) To understand the Structure and Functions of invertebrates and vertebrates
- 2) To understand the organs of respiration and excretion and their functioning in invertebrates.
- 3) To analyse the nervous systems of various groups in invertebrates
- 4) To evaluate the larval forms of invertebrates to acquire knowledge on various organ system of vertebrates

UNIT - I: Respiration and Excretion of Invertebrates

Organs of respiration: gills, lungs and trachea-Respiratory pigments-Mechanism of respiration-Excretion-Organs of excretion: coelom, coelomoducts, nephridia and Malpighian tubules-Mechanisms of excretion-Excretion and osmoregulation. f

UNIT - II: Nervous System of Invertebrates

Primitive nervous system: Coelenterata and Echinodermata-Advanced nervous system: Annelida, Arthropoda (crustacean and insecta) and Mollusca (Cephalopoda)-Trends in neural evolution.

UNIT - III: Invertebrates Larvae

Larval forms of free living invertebrates-Larval forms of parasites-Strategies and evolutionary significance of larval forms-Minor Phyla-Concept and significance-Organization and general characters.

UNIT - IV: Skin and Skeletal System of Vertebrates

General structure and functions of skin and its derivatives-glands, scales, horns, claws, nail, hooves, feather and hairs. Skeletal elements of the body-account of jaw suspensorium, vertebral column-limbs and girdles.

UNIT - V: Respiratory System and Nervous System of Vertebrates

Respiratory system-characters of respiratory tissue- Internal and external respiration-Comparative account of respiratory organ. Nervous system-Anatomy of the brain and spinal cord in relation to their functions-Nerves-Cranial-peripheral and autonomous nervous system.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Understand the morphological features and physiological functions like Respiration, reproduction and nervous system of invertebrates and Vertebrates.
- 2) Understand the various salient features of higher invertebrates and
- 3) Vertebrates.
- 4) Differentiate the patterns of functioning of various organ systems in invertebrates and vertebrates.
- 5) Know the structural organization and functioning of various organs in invertebrates and vertebrates.
- 6) Understand the Structural functioning of respiratory and nervous system

Text Books

1. Arumugam, N., T. Murugan, B. Ramanathan and M.G. Rangunathan. (2019). *A Text Book of Invertebrates*, Saras Publications, Nagercoil, Tamil Nadu.
2. Ekambaranatha Ayyar, M. (1973). *A Manual of Zoology – Part I: Invertebrata*. S.Viswanathan (Printers and Publishers) Pvt., Ltd. Madras.
3. Ekambaranatha Ayyar, M. (1973). *A Manual of Zoology Part – II: Chordata*. S.Vishvanathan Printers and Publishers, Pvt. Ltd., Madras.
4. Jordan, E. L. and P. S. Verma, (2017). *Chordate Zoology and Elements of Animal Physiology*, S. Chand & Co., Ltd., New Delhi.
5. Jordon, E. L. and P.S Verma, (2015). *Invertebrate Zoology*. S. Chand and Co. Ltd., New Delhi.
6. Saxena, R.K. and S. Saxena. (2015). *Comparative Anatomy of Vertebrates*, M.V.Learning, UK.
7. Wells, H.G. (2018). *Text Book of Biology, Part 1: Vertebrata*, Createspace Publishing Company, USA.

Supplementary Readings

1. Arumugam, N. (2014). *Animal diversity Volume - 1 – Invertebrata*. Saras Publication, Nagercoil, Tamil Nadu.
2. Arumugam, N. (2014). *Animal diversity Volume - 2 – Chordata*. Saras Publication, Nagercoil, Tamil Nadu.
3. Barrington E. J. W. (2012). *Invertebrate structure and function*. Affiliated East West Press Pvt. Ltd., New Delhi.
4. Brusca, R.C., W. Moore and S.M. Shuster. (2016). *Invertebrates*. Oxford University Press, USA.
5. Kent, G.C. (2015). *Comparative Anatomy of the Vertebrates*. McGraw Hill, New York.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
C01	3	3	2	3	3
C02	3	3	3	3	2
C03	2	3	3	3	3
C04	3	3	3	3	3
C05	3	3	2	3	3

Semester- I	22PZOOC12: DEVELOPMENTAL BIOLOGY	CREDITS: 3 HOURS: 4
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COURSE OBJECTIVES

- 1) To understand the various concepts of development
- 2) To study gametogenesis and process of fertilization
- 3) To learn the processes of embryogenesis, organ formation and differentiation
- 4) To analyse the embryonic induction and teratogenesis
- 5) To critically explore assisted reproductive technologies for human welfare

UNIT - I: Introduction to Embryology

Scope of embryology. Gametogenesis-spermatogenesis, oogenesis and egg membranes. Fertilization - mechanism of fertilization, capacitation, acrosomal reaction, cortical reaction and significance of fertilization. Cleavage- cleavage in frog and chick. Gastrulation-gastrulation in frog and chick. Fate map of amphibians, aves and mammals.

UNIT - II: Embryonic Adaptations and Parthenogenesis

Foetal membranes and their functions-Implantation-types and mechanism of implantation. Placentation-placenta, structure, types and physiology of placenta. Parthenogenesis-types, mode of action of agents in artificial parthenogenesis-significance of parthenogenesis.

UNIT - III: Organogenesis and Differentiation

Organogenesis-development of brain, eye and heart of mammals (Rabbit)-Differentiation, types, chemical basis, selective action of genes, changing pattern of protein synthesis and sequence of gene action in development-stem cells, role of microenvironments in differentiation.

UNIT - IV: Embryonic Induction and Teratogenesis

Embryonic induction-types, embryonic induction in amphibians, reptiles, birds and mammals. Neural induction, gene activation, mechanism of neural induction and chemical basis of neural induction. Teratogenesis-genetic teratogenesis-in human beings and animals, teratogenic agents and mechanism of teratogenesis.

UNIT - V: Reproductive Technology for Human Welfare

Causes of impotency and sterility in the male-causes of sterility in the female-Treatment of sterility-Artificial insemination in human beings-Infertility in men and women.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Acquire knowledge on reproduction and development
- 2) Understand process of fertilization
- 3) Understand the whole process of embryogenesis
- 4) Acquisition of skills in common methods and practices followed in developmental biology related laboratory activities
- 5) Take up jobs in fertilityclinics and research labs

Text Books

1. Arora, P.M. (2014). *Embryology*, Himalaya publishing House, New Delhi.
2. Arumugam, N. (2014). *A Text Book of Embryology (Developmental Biology)*, Saras Publications, Nagercoil, Tamil Nadu.
3. Balinsky, B.I. (2012). *An Introduction to Embryology*, 4th Edition, Saunders College Publishing Ltd, New York.
4. Berrill, N.J. and G. Karp. (1978). *Development Biology*, Tata McGraw Hill Publishing Co., Ltd, New Delhi
5. Philip Grant (1977). *Biology of Development Systems*, University of Oregon
6. Verma, P.S. and V.K. Agarwal. (2017). *Chordate Embryology (Developmental Biology)*, S. Chand and Co., New Delhi.

Supplementary Readings

1. Berry A.K. (2016). *An Introduction to Embryology*. Emkay Publications, New Delhi.
2. Carlson, B.M. (2014). *Patterns Foundations of Embryology*, McGraw Hill.
3. Jain P.C. (2013). *Elements of Developmental Biology*. Vishal Publishing Co.,
4. Madhavan K. S. (2018). *Developmental Biology*. Arjun Publishing House, Punjab.
5. Sastry, K.V. and Shukal, V. (2012). *Developmental Biology*. Rastogi Publication, Meerut, Uttar Pradesh.
6. Subhadra Devi, V. (2018). *Inderbir Singh's Human Embryology*, Jaypee Brothers Medical Publishers, New Delhi.
7. Wolpert, L., Tickle, C. and Arias, A.M. (2015). *Principles of Development*. Oxford University Press, USA.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
C01	2	3	2	3	3
C02	3	3	3	3	2
C03	3	2	3	2	3
C04	2	3	3	3	2
C05	3	2	3	3	3

Semester- I	22PZOOC 13: CELL AND MOLECULAR BIOLOGY	CREDITS: 3 HOURS: 4
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COURSE OBJECTIVES

- 1) To understand the molecular basis of cell structure and functions
- 2) To learn the structure and functions of various organization and cell membrane
- 3) To learn bioenergetics and biogenesis
- 4) To learn structure and replication of DNA
- 5) To learn various molecular techniques

UNIT - I: Cell Structure and Cell Membrane

Cell Structure: Introduction – Structural organization of prokaryotic and eukaryotic cells; structural differences of prokaryotic and eukaryotic cells.

Cell Membrane: Ultrastructure of plasma membrane – chemical composition of cell membrane, lipid bilayer – unit membrane concept – Fluid mosaic model; Functions of Plasma membrane; membrane transport – cell adhesion – cell recognition – antigen specificity – hormone receptors.

UNIT - II: Organelles of Endomembrane

Golgi apparatus & secretion: Ultra structure – chemical composition – origin of golgi complex – process and mechanism of secretion – Type of secretion – Function of Golgi apparatus.

Lysosome: Characteristics of lysosomal membrane and enzymes – Polymorphism of lysosome – functions of lysosome.

Endoplasmic reticulum and ribosomes: morphology and functions of endoplasmic reticulum – Structure of ribosomes and rRNAs – Organization of ribosomes – Role of ribosomes in protein synthesis.

UNIT - III: Organelles of Bioenergetics & Biogenesis

Organelles of Bioenergetics: Mitochondria – Ultra structure – respiratory chain complex; chemical composition and enzyme distribution – role in metabolism for cellular energetic – Anaerobic glycolysis, Pasteur effect – Krebs cycle – Formation of ATP. Chemical and conformation coupling hypothesis; shuttle system – Glycerophosphate and malate shuttle.

Organelle of Biogenesis: Chloroplast – Ultra structure – photochemical reaction in biogenesis – Light reaction and Dark reaction – Role of CO₂ and H₂O in photosynthesis – 'Z' scheme.

UNIT - IV: DNA Structure and Replication

Structure, Chemical composition – Types and their importance – Properties of DNA – Denaturation, Renaturation and Hybridization. **DNA replication:** Prokaryotic and eukaryotic DNA replication – Semi – conservative replication mechanism, enzymes and necessary proteins origin, initiation, Termination – DNA polymerase, telomerase and mode of action – replication factors.

UNIT - V: RNAs Structure and Transcription

Structural features of RNAs: Structure of rRNA in prokaryotes and eukaryotes – structure of tRNA and anti codon features – structure of mRNA in prokaryotes and eukaryotes. **Transcription and processing of RNA:** Genetic code – Prokaryotic and eukaryotic transcription – RNA polymerases, general and specific transcription factors – regulatory elements – mechanism of transcription. Post transcriptional modifications.

Translation – Prokaryotic and eukaryotic translation – translational machinery – mechanism of initiation, elongation and termination – regulation of translation. Post translational modifications.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Acquire knowledge on cellular structure and functions
- 2) Understand the process of energetic and genesis in cells
- 3) Interpret the structural and functional significances of DNA and RNA
- 4) Take up jobs in molecular biology labs and clinical labs
- 5) Acquire the knowledge about RNAs and its Transcription

Text Books

1. DeRobertis, E.D.D and DeRobertis, E.M.F. (2017). *Cell and Molecular Biology*.
2. Gupta. P.K. (2003). *Cell and Molecular Biology*, Rastogi Publication, Meerut, India.
3. Lewin, B. (2000). *Gene VII*, Oxford University Press, London.
4. Lodish, H., Berk, A., Zipursky, S.L., Matiudaira, P., Baltimore, D. and Darnell, J.(2000). *Molecular Biology of the Cell*, W.H. Freeman and company, New York.
5. Pollard, T.D., W.C. Earnshaw, J.L. Schwartz and G. Johnson. (2017). *Cell Biology*, Elsevier.
6. Verma P.S. and V.K. Agarwal. (2015): *Cell Biology, Genetics, MolecularBiology, Evolution and Ecology*, S. Chand and Company, New Delhi.

Supplementary Readings

1. Alberts, B., A.D. Johnson and J. Lewis. (2014). *MolecularBiology of the Cell*. W.W. Norton & Co., USA.
2. Berk, A., C.A. Kaiser and H. Ledish. (2016). *Molecular Cell Biology*. WH Freeman, USA.
3. Cooper, G.M. and R.E. Hausman. (2013). *The Cell: A MolecularApproach*. Sinauer Associates Inc., USA.
4. Malathi, V. (2012). *Essentials of Biology*. Pearson Education, Chennai, India.
5. Verma, P.S. and V.K. Agarwal. (2016). *Cell Biology*. S.Chand & Co., NewDelhi.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	2	3	3
CO3	2	3	3	2	3
CO4	3	3	3	3	2
CO5	3	3	3	2	3

Semester- I	22PZOOP 14: Core Practical I (Covering 22PZOOC 11, 12 & 13)	CREDITS: 6 HOURS: 12
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Structure and functions of Invertebrates and Vertebrates

Dissections

1. Dissection of Cockroach – Digestive and Nervous system, Dissection of Prawn.
2. Nervous system and mounting of appendages.
3. Dissection of Fish – Nervous system, Respiratory system and Digestivesystem.
4. Observation and Classification of the following Specimens by giving reasons: Paramecium, Sycon, Obelia, *Taenia solium*, Neries, Prawn, Freshwater mussel, Amphioxus, Hyla, Calotes, Rat.
5. Study of Adaptations to the mode of life: *Trypanosoma*, Corals, *Ascaris*, *Wuchereria*
6. Biological Significance of the following forms: Peripatus, Sea anemone, Anabas, Arius, Exocoetus, Eel, Amblystoma, Woodpecker, Ant-eater, Lingula, Sagitta and Phoronis.
7. Relate structure and function of the following forms: Taenia, Scolex, Nereis – Parapodium, Ctenoid and Quill feather of pigeon.

Developmental Biology

1. Demonstration of male and female reproductive system in mammals (rat) –specimens.
2. Dissection and mounting of chick blastoderm to identify different stages in chickdevelopment.
3. Observation of early development of frog – two celled stage, 4 celled stage, 8 celled stage and sixteen celled stage, blastula, gastrula and yolk plug stage.
4. Regeneration in amphibian – frog tadpole.
5. Observation of metamorphosis in insects.
6. Observation of different types of placenta – slides.
7. Analysis of excretory products – chick embryo.
8. Histology of mammalian testis and ovary – slides.
9. Observation of uterine cycles in mammals – slides.

Cell and Molecular Biology

1. Light Microscope – components, use and principles.
2. Mounting of polytene chromosomes from salivary gland of Chironomus larva.
3. Squash preparation of different stages of meiosis in grasshopper testis.
4. Squash Preparation of mitosis in onion root tips.
5. Study of Micrometry: a) Camera lucida, b) Stage micrometer, c) Ocularmicrometer.
6. Determination of Nucleo – Cytoplasmic index.
7. Identification of drumstick chromosome from human blood smear preparation.
8. Identification of Barr body from buccal smear preparation.
9. Histochemical Localization of DNA and RNA.
10. Estimation of DNA and RNA of the samples.

Semester- I	22ZOOE15-1 TOXICOLOGY	CREDITS: 3 HOURS: 3
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COURSE OBJECTIVES

- 1) To learn the concepts and processes involved in toxicology
- 2) To understand the various methods to know absorption and distribution of toxicants
- 3) To study the biotransformation and excretion of toxicants
- 4) To learn the impacts of toxicants and human beings
- 5) To learn the application of antidotes and Biomonitoring

UNIT - I: Introduction to Toxicology

Definition – Brief history of toxicology — Disciplines of toxicology – Scope of toxicology– Toxicity methods – Acute toxicity tests – Sub-acute toxicity test – Chronic toxicity test. Bio-assay – Determination of LC50 and LD50 – Dose – Response relationship – Indices of toxicity – Threshold dose – Margin of safety and therapeutic index – Selective toxicity – Response of toxicity – Factors influencing toxicity – Chemical interaction – Types of interactions.

UNIT - II: Exposure Route, Absorption and Distribution of Toxicants

Route of exposure of Toxicants: Dermal route – Inhalation route – Ingestion route. Absorption of Toxicants: Introduction – Mechanism of absorption – Passive transport and carrier mediated transport – Factors affecting absorption. Distribution of Toxicants: Introduction – Factors determining the distribution – Binding of plasma protein – The storage depots – Liver, Kidney, Fat and Bone – Membrane barriers.

UNIT - III: Biotransformation and Excretion of Toxicants

Biotransformation: Introduction – Pattern of Biotransformation – Phase I reaction – Oxidation – Mixed Function Oxidase System – Reduction reaction – Hydrolysis – Phase II reaction – Biochemical conjugation – Glucuronidation – conjugation with Glutathione – Sulfate conjugation – Acetylation and Methylation – Amino acid conjugation – Deactivation versus Bioactivation. Excretion of Toxicants: Urinary excretion – Biliary excretion – Lungs and other routes.

UNIT - IV: Toxic Effects on Human

Categories of toxic effects – Local and systemic effects – Reversible and irreversible effects – Immediate and delayed effects – Effects on biomolecules – Effects on target organs: Neurotoxic effects – Hepatotoxic effects – Genotoxic effects – mutagenic – Teratogenic – carcinogenic effects.

UNIT - V: Antidotes and Biomonitoring

Antidotes: Classification of antidotes – Mechanism of action of antidotes–Specific antidotes for metals and pesticides. Biomonitoring: Introduction – Objectives – Biological Monitoring Programme – Parameters for Biomonitoring – Bioindicators and Environmental Monitoring – Classification of Bioindicators – Criteria for Selection of Bioindicators – Traditional Bioassays – Biotechnology Based Bioassays – Microbial Indicators – Plant Indicators – Animal Indicators – Aeroallergens – Human System – Benefits and Disadvantages of Bioindicators.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Carry out toxicological analysis of various environmental samples
- 2) Make observations and biochemical analysis of biological samples
- 3) Carry out toxicological testing using live specimen to determine toxicity of toxicants
- 4) Take up jobs in toxicological research institutions and clinical labs
- 5) Understand the toxic effect of toxicants and biotransformation

Text Books

1. Barile, F.A. (2017). *Principles of Toxicology Testing*. CRC Press, USA.
2. Frank C. Lu. (1985). *Lu's Basic Toxicology*. Hemisphere Publication Corporation Washington, N.Y. London.
3. Gupta, P.K. and D.K. Salunka (1985). *Modern Toxicology*. Vol. I and II, Metropolitan, New Delhi.
4. Kent, C. (1998). *Basics of Toxicology*. John Wiley & Sons. New York.
5. Lee, B.M. and S.Kacew. (2018). *Lu's Basic Toxicology*, Informa Healthcare.
6. Pandey, K., J.P. Shukla and S.P. Trivedi. (2011). *Fundamentals of Toxicology*. New Central Book Agency, New Delhi.
7. Pandey, K., J.P. Shukla and S.P. Trivedi. (2013). *Fundamentals of Toxicology*, New Central Book Agency, New Delhi.
8. Roberts, S.M., R.C. James and P.L. Williams. (2015). *Principles of Toxicology: Environmental and Industrial Applications*. WileyBlackwell.
9. Sharma, P.D. (1996). *Environmental biology and toxicology*. Rastogi Publication, Meerut, India
10. Stine, E.E. and T.M. Brown. (2015). *Principles of Toxicology*. CRC Press, USA.
11. Vija Byung-Mu Lee, S. Kacew and H.S. Kim. (2017). *Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment*. CRC Press, USA.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	3
CO2	3	2	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester- I	22ZOOE15-2 APICULTURE	CREDITS: 3 HOURS: 3
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COURSE OBJECTIVES

- 1) To acquire knowledge of honey bees and their social values.
- 2) To acquire knowledge about the rearing techniques and different types of artificial hives
- 3) To acquire the clear knowledge about the bee enemies, diseases, and their control measures.
- 4) To acquire knowledge about the importance of bee products and their marketing.
- 5) To entrepreneur motivation for practicing apiculture as cottage industry.

UNIT - I: Classification and Biology of Bees

History and scope of Bee keeping – Present status of Apiculture in India – Basic concepts of morphology of Honey bees – indigenous, exotic – Honey bee species and identification – Types of honey bees – Social Organization of Bee Colony – Queen, drone, worker – Swarming and pheromones – Life Cycle of Honey Bees.

UNIT - II: Rearing of Bees

Traditional bee keeping – Modern beekeeping – Urban or backyard beekeeping – Basic requirements of Tools for starting bee keeping – Bee keeping equipment – Apiary Management – Artificial bee hives – types of bee hives – BIS standard Tools used in apiculture – Bee breeding and multiplication of colonies – Queen reaching technique. Honey extraction techniques.

UNIT - III: Diseases and Enemies

Enemies of honeybees – Wax Moth, Ants, Wasps, Microbes, Mites, and other Pests – Diagnosis and identification– Bacterial, viral, fungal and protozoan diseases – control measures.

UNIT - IV: Bee Economy

Products of Apiculture industry and its uses – Honey, bees wax, propolis, pollen, royal jelly, and venom– Significance of bee products – Marketing of bee products – Economic importance of Honey and bee wax – Honey yield in the National and International market – Uses of honey in Indian medicine – Other valuable by-products of honey bees.

UNIT - V: Entrepreneurship in Apiculture

Bee Keeping Industry – Economics in small scale and large scale bee keeping – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens – Economic Value of Commercial Beekeeping – Prospects of apiculture as self-employment venture–Funding sources for beekeeping projects

COURSE OUTCOME

At the end of the course, the student will be able to

- 1) The students will be able to understand the basics of beekeeping.
- 2) The students will be able to understand the role and different types of bee hives.
- 3) The students will be able to understand the bee enemies, diseases, and their control measures.
- 4) The students will be able to learn the economic importance of honey bee products and their marketing.
- 5) Developed into an Entrepreneurship

Text Books

1. Abrol, D. P. (1997). *Bees and Beekeeping in India*. Kalyani Publishers, Ludhiana.
2. Amsath, A. and M. Govindarajan. (2013). *Apiculture*. Lambert Academic Publishing.
3. Arumugam, N., T. Murugan, J. Rajeshwar, and R. Prabhu. (2009). *Applied Zoology*. Saras Publication, Nagercoil.
4. Mehrotra, K.N. and D.S. Bisht. (1981). *Apiculture in Relation to Agriculture*, IARI.
5. Mishra, R.C. (1995). *Honey Bees and Their Management in India*. ICAR, New Delhi.
6. Morse, R.A. (1990). *The ABC & XYZ of Bee culture*, 40th ed., A.I Root & Co, Medina, Ohio.
7. Nalina Sundari, M.S. (2006). *Entomology* M.J.P Publications, Chennai
8. Prost, P.J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
9. Rare, S. (1998). *Introduction to Bee keeping*, Vikas Publishing House.
10. Shukla, G.S. and V.B. Upadhyay. (1997). *Economic Zoology*. Rastogi Publications, Meerut.
11. Singh S. (1982). *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	2
CO2	3	2	3	3	3
CO3	3	3	2	3	3
CO4	3	3	3	2	3
CO5	2	3	3	3	3

Semester- I	22ZOOE15-3 PUBLIC HEALTH AND HYGIENE	CREDITS: 3 HOURS: 3
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COURSE OBJECTIVES

- 1) To learn important vector borne diseases of human being
- 2) To understand diseases caused by protozoans
- 3) To acquire knowledge in diseases caused by helminthes
- 4) To learn common air, food and water borne disease

UNIT - I: Introduction to Important Diseases to Human Beings

Mosquito borne diseases – malaria, filariasis and chikungunya – symptoms and treatments. Morphology, life cycle and control measures of vector mosquitoes– *Anopheles*, *Culex* and *Aedes* species and vector management.

UNIT - II: Vector Borne Diseases to Human Beings

Vector borne diseases – Kala – azar, typhoid, amoebic dysentery, cholera and sleeping sickness – Symptoms and treatments – Morphology, life cycle and control measures of sand flies, House flies and Tsetse fly.

UNIT - III: Protozoan Diseases to Human Beings

Protozoan diseases – Trypanosomiasis, Leishmaniasis and Trichomoniasis symptoms and treatments – Morphology, life cycle and control measures of Trypanosoma, Leishmania and Trichomona.

UNIT - IV: Helminthes Diseases to Human Beings

Helminthes diseases – Taeniasis, Schistosomiasis and Ascariasis – symptoms and treatments – Morphology, life cycle and control measures of Taenia solium, Schistosoma and Ascaris.

UNIT - V: Air, Food and Water Borne Diseases

Air borne diseases: Tuberculosis, Diphtheria and pneumonia. Food and water borne diseases: sources of water pollutants – cholera, botulism, shigellosis and typhoid fever. Cancer – sources, different types of tumors and treatment.

COURSE OUTCOME

At the end of the course, the student will be able to

- 1) Analyse various common vectors and diseases, causing
- 2) Impart skills the general Public for public health and hygiene
- 3) Work in clinical labs
- 4) Take up research on issues related to public health and hygiene
- 5) Understand the Public health and hygiene and its importance

Text Books

1. Dubey, R.C. and D.K. Maheswari. (2005). *A Text Book of Microbiology*, S.Chand & Company Ltd., New Delhi.
2. Gupta, P.K. and V. Ramprakash. (1985). *Advance in Toxicology and Environmental Health*. Jagmender Book Agency, New Delhi.
3. Jordon, E.L. and P.S. Verma. (2005). *Invertebrate Zoology*, S.Chand & Company Ltd., New Delhi.
4. Parthiban, M. and B.Vasantharaj David. (2007). *Manual of Household & Public Health Pests and Their Control*, Namrutha Publications, Chennai.

- Rathinasamy, G.K. (1974). *A Handbook of Medical Entomology and Elementary Parasitology*. Viswanathan Printers and Publication Pvt., Ltd., Chennai.

Supplementary Readings

- Bogitsh, B.J., C.E. Carter, and T.N. Oeltmann. (2012). *Human Parasitology*. Academic Press, USA.
- Nelson, K.E. and C. Williams. (2013). *Infectious Disease Epidemiology*. Jones and Bartlett Publishers, USA.
- Ruth Leventhal. (2011). *Medical Parasitology*. F.A. Davis Company, USA.
- Wagh, S.R. and V.K. Deshmukh. (2015). *Medical Entomology*. Success Publications, Tiruchirappalli, Tamil Nadu.
- Wiser, M.F. (2012). *Protozoa and Human Disease*. Garland Science, New York, United States.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	3
CO2	3	3	2	3	3
CO3	3	3	3	2	3
CO4	3	2	3	3	3
CO5	3	3	3	3	2

Semester- II	22P ZOOC 21: ANIMAL PHYSIOLOGY	CREDITS: 3 HOURS: 4
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COURSE OBJECTIVES

- 1) To learn the significance of food and physiology diagram
- 2) To understand the significance of excretory and osmoregulation system.
- 3) To study the functioning of cardiovascular system
- 4) To study respiratory and nervous systems including various receptors

UNIT - I: Food and Digestion

Composition of food – classification of nutritive substances – comparative physiology of digestion – digestion in mammals – digestive enzymes – absorption – hormonal control of digestion – BMR – BMI.

UNIT - II: Excretion and Osmoregulation

Excretion – Nitrogenous wastes and their formation – Patterns of Excretion in different animal groups – Mammalian excretory system – structure and functions of vertebrate kidney – Mechanism of urine formation – Acid-base balance – electrolyte balance – Hormonal control of kidney function in mammal. General concepts of osmoregulation – osmoregulation in invertebrates and vertebrates.

UNIT - III: Circulation

Major types of body fluids – circulation of body fluids and their regulations – Composition of blood – blood groups – clotting mechanism – buffer system of blood – Circulation of blood in vertebrates – Open and Closed circulatory systems – Arthropod heart – Chambered hearts and booster pumps. Structure of mammalian heart, origin, conduction and regulations of heart beat – cardiac cycle and ECG.

UNIT - IV: Respiration

Respiration in vertebrate – Respiratory organs and their ventilation – Integumentary respiration – bronchial respiration – lung respiration – mechanism of respiration in vertebrates – Regulation of breathing – Neural and chemical regulation – Transport of Oxygen – Respiratory pigments – Bohr's effect – Transport of CO₂ – Haldane's effect.

UNIT - V: Nervous system, Muscle and Sense organs

Nervous System: Structure of neuron – Transmission of nerve impulse – axonal transmission – theories of excitation – synaptic transmission – nervous system (central & Peripheral) – neuroendocrine system – hormones and their functions. **Muscle:** Types and Structure – chemical composition – mechanism of muscle contraction. **Sense Organs:** Mechanoreceptors – chemoreceptors – photoreceptors – phonoreceptors – equilibrium receptor – Bioluminescence.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Understand the normal physiological functions and necessity to maintain a healthy Life
- 2) Get an opportunity to understand various factors that could lead to altered physiological functions and thereby health problems
- 3) Perform various physiological experiments and observations

- 4) Take up jobs in clinical labs and research institutes
- 5) Understand the various physiological functions and importance

Text Books

- 1) Arumugam, N. and A. Mariakuttikan. (2017). *Animal Physiology*, Saras Publications, Nagercoil, Tamil Nadu.
- 2) Goldstein, L. (1977). *Introduction to Comparative Physiology*. Holt, Rinehart and Winston, New York.
- 3) Hoar, W.S. (1966). *General and Comparative Physiology*. Prentice Hall of India, New Delhi.
- 4) Prosser, L. and A. Brown, (1965). *Comparative Physiology*. Saunders Company, London.
- 5) Rastogi, S.C. (2016). *Essentials of Animal Physiology*, New Age International Publishers, New Delhi.
- 6) Verma, P.S., B.S. Tyagi and V.K. Agarwal. (2015). *Animal Physiology*. S. Chand & Company Ltd, New Delhi.
- 7) Wilson. A. (1979). *Principles of Animal Physiology*. Macmillan Publishing Co., Inc. New York.

Supplementary Readings

- 1) Arora, M.P. (2018). *Animal Physiology*. Himalaya Pub. House Pvt.Ltd., New Delhi.
- 2) Arumugam, N. (2014). *Animal Physiology*. Saras publications. Nagercoil, Tamil nadu.
- 3) Saxena, S. (2012). *Animal Physiology*. Oxford University Press, USA.
- 4) Sobti, R.C. (2011). *Animal Physiology*. Narosa Publishing House, New Delhi.
- 5) Tomar, B.S. and Neera Singh. (2016). *Animal Physiology*. Pragati Prakashan, Meerut, Uttar Pradesh.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	2
CO2	3	3	2	3	3
CO3	3	2	3	3	3
CO4	3	3	3	2	3
CO5	3	3	2	3	3

Semester- II	22PZOOC 22: GENETICS	CREDITS: 3 HOURS: 4
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COURSE OBJECTIVES

- 1) To learn the fundamental concepts of genetics
- 2) To study human health related genetic problems, qualitative and quantitative traits and population genetics
- 3) To learn the structure of genes and their regulation
- 4) To acquire skills in chromosomal alterations, gene mutations and cancer.
- 5) To learn application of genetics concepts in microbial genetics and genetic engineering.

UNIT - I: Principles and Concepts of Gene and Gene mapping

Mendelian principles: Law of Dominance, Law of Segregation and Law of Independent assortment; extensions of laws of inheritance principles – Gene Interactions, dominant epistasis.

Pleiotrophy: Penetrance and expressivity – Linkage and crossing over – concept, theories and example – linkage maps (X chromosome) gene mapping in drosophila, Coincidence and Interference – multiple allele – ABO and Rh blood group in man.

UNIT - II: Quantitative, Population and Human Genetics

Polygenic inheritance: concept, mode of inheritance of skin colour in man – heritability and its measurements – normal karyotypes – Syndromes related to numerical variations of chromosomes – pedigree analysis – genetic counseling, Hardy-Weinberg law of genetic equilibrium.

UNIT - III: Fine Structure of Gene and Regulation of Gene action

Fine structure of gene – regulation of gene action – Lac and His” Operon system– genes and metabolism – inborn errors of carbohydrate, proteins and lipid metabolism in man. One gene one enzyme concept – One gene one polypeptide concept.

UNIT - IV: Chromosomal Alterations, Gene Mutation and Oncogenes

Chromosomal aberrations – types and causes – point mutation – mutagens– chemical mutagens – molecular mechanism of gene mutation, mutant types – lethal, conditional biochemical loss of function – oncogene and cancer.

UNIT - V: Microbial Genetics and Genetic Engineering

Microbial genetics: Methods of genetic transduction – sex-duction – genetic engineering – Restriction enzymes – recombinant DNA techniques – applications of recombinant DNA technology.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Interpret phenotypic expressions based on genotype
- 2) Understand and interpret genetically linked diseases
- 3) Perform blood group analysis and test metabolic disorders Working in clinical laboratories and take up researches
- 4) Understand the chromosomal alterations and significance of gene

Text Books

- 1) Aluwalia, K.B. (1991). *Genetics*, Wiley Eastern Ltd., New Delhi.
- 2) Krebs, J.E., E.S. Goldstein and S.T. Kilpatrick. (2015). *Lewins's Genes XI*, Jones and Bartlett Publishers, Inc., USA.
- 3) Sarin, C. (1990). *Genetics*. Tata McGraw-Hill Publishing Co. Ltd, New Delhi.
- 4) Snustad, D.P. and M. J. Simmons. (2017). *Principles of Genetics*, John Wiley & Sons Inc., India.
- 5) Tamirin, R.H. (2004). *Principles of Genetics'* Tata McGraw-Hill Publishing Company Ltd. New Delhi.
- 6) Verma P. S. and V. K. Agarwal, (2015): *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand and Company, New Delhi.

Supplementary Readings

- 1) Gangane, S.D. (2017). *Human Genetics*. Elsevier, India.
- 2) Klug, W.S., M.R. Cummings and C.A. Spencer. (2016). *Concept of Genetics*. Pearson, UK.
- 3) Snustad, P.D. and M.J. Simmons. (2011). *Genetics*. John Wiley & Sons, India.
- 4) Tamarin, R. (2017). *Principles of Genetics*. McGraw Hill, New York, USA.
- 5) Watson, J.D., A.B. Tania and P.B. Stephen. (2017). *Molecular Biology of the Gene*. Pearson, UK.
- 6) Weaver, R.F. and P.W. Hedrick. (2015). *Genetics*, Brown (William C.) Co., U.S.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	2	2	3	3	3
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	2	3	3

Semester- II	22PZOOC23: BIOCHEMISTRY	CREDITS: 3 HOURS: 4
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COURSE OBJECTIVES

- 1) To learn classification and metabolism of carbohydrates
- 2) To understand the structure and metabolism of protein
- 3) To learn the structure and functions of lipids
- 4) To acquire knowledge about various enzymes and hormones and their actions
- 5) To acquire knowledge about the significance of vitamins

UNIT - I: Buffers and Carbohydrate

pH and buffers – Water, carbon dioxide and oxygen, properties, outlines of Biochemical energies.

Carbohydrates: Methods of study of intermediary metabolism of Carbohydrates; A general account of classification – Structure and properties of mono and polysaccharides – metabolism of carbohydrates, glycolysis, Citric acid cycle, Gluconeogenesis – defect in carbohydrate metabolism.

UNIT - II: Proteins

Classification and isolation – The fundamental physiochemical principles and structure of amino acids, peptides and proteins – protein metabolism – Metabolism of amino acids in general.

UNIT - III: Lipids

Classification of lipids – Structure and chemistry of single and compound lipids; metabolism of fats and fatty acids – Defects in lipid metabolism.

UNIT - IV: Enzymes and Hormones

Enzymes: Classification – Enzyme kinetics – Effects of substrate concentration – Inhibition and mechanism of enzyme action – Co-enzymes.

Hormones: Classification, biosynthesis and function – Pancreatic and thyroid hormones.

UNIT - V: Nucleic acids and Vitamins

Composition and structure of nucleic acids: RNA and DNA – Major pathways in the synthesis of RNA and DNA.

Vitamins – occurrence – grouping – deficiency diseases.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Understand various micro and macro molecules and their significance
- 2) Discriminate various metabolic disorders
- 3) Take up jobs in clinical labs
- 4) Analyze biological samples of bio-chemical importance
- 5) Understand the metabolism of macromolecules

Text Books

1. Agarwal, R.A., A.K. Srivastava and K. Kumar. (2014). *Animal Physiology and Biochemistry*. S. Chand and Company. New Delhi
2. Ragland, A. and N. Arumugam. (2015). *Biochemistry and Biophysics*, Saras Publications, Nagercoil, Tamil Nadu.
3. Rodwell, V.W. (2018). *Harper's Illustrated Biochemistry*, McGraw-Hill Education.
4. Sastry, K.V. (2011). *Animal Physiology and Biochemistry*. Rastogi Publications, Meerut. New Delhi
5. Satyanarayana, U and U. Chakrapani. (2017). *Biochemistry*, Elsevier New Delhi.
6. Vasudevan, D.M., S. Sreekumari and K. Vaidyanathan. (2019). *Textbook Of Biochemistry for Medical Students*, Jaypee Brothers Medical Publishers, New Delhi.

Supplementary Readings

1. Creighton, T.E. (2012). *Protein Structure and Molecular Properties*, W.H. Freeman & Co.
2. Firley, J.L. and G.L. Kilgour. (1971). *Essentials of Biological chemistry*, Affiliated East West Press, London.
3. Freifelder, D. (2007). *Physical Biochemistry* W.H. Freeman & Co.
4. Nelson, D.L. and M.M. Cox. (2013). *Lehninger Principles of Biochemistry*, W.H. Freeman.
5. Segal, I.H. (2015). *Biochemical Calculations*, John Wiley and Sons
6. Voet, D. and J.G. Voet. (2005). *Biochemistry* John Wiley & Sons.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3
CO2	3	3	2	3	3
CO3	3	3	3	2	3
CO4	3	2	3	3	3
CO5	3	3	2	3	3

Semester- II	22PZOO 24: Core Practical II (Covering 22PZOO 21, 22 & 23)	CREDITS: 6 HOURS: 12
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Animal Physiology

- 1) Effect of enzyme concentration on the activity of salivary amylase
- 2) Effect of substrate concentration on the activity of salivary amylase
- 3) Effect of pH concentration on the activity of salivary amylase
- 4) Oxygen consumption of fish. – Unit metabolism
- 5) Effect of thyroxin on the respiratory metabolism of fish.
- 6) Counting of blood cells (RBC and WBC).
- 7) Quantitative estimation of haemoglobin.
- 8) Quantitative estimation of proteins.
- 9) Biochemical analysis of protein, Carbohydrates and Lipids (Qualitative).

Genetics

- 1) Experiments on Mendelian inheritance.
- 2) Experiments on polygenic inheritance.
- 3) Human traits survey and data collection.
- 4) Gene frequency calculations in population – Autosomal, multiple alleles and sex linked genes.
- 5) Testing the significance of genetic data – Chi-square test.
- 6) Human pedigree construction to study the inheritance of autosomal character.
- 7) Human pedigree for sex linked character and counseling.
- 8) Culturing and maintenance of *Drosophila* in lab – Demonstration.
- 9) Identification of sex and mutant characters in *Drosophila*.
- 10) Karyotyping of normal man using metaphase chromosomal plate.
- 11) Identification of human syndromes from karyotyping.

Biochemistry

- 1) Preparation and use of buffers.
- 2) Qualitative tests for carbohydrates, Amino acids, proteins lipids and nucleic acids; amines urea (thiourea).
- 3) Determination of the molecular weight of a monocarboxylic amino acid by Sorenson formol titration.
- 4) Determination of isoelectric pH of a protein.
- 5) Estimation of glycogen, phosphate, cholesterol and protein in tissues.
- 6) Determination of protein digestion by trypsin. Fractionation and estimation of serum proteins.
- 7) Estimation of RNA and DNA in tissues.
- 8) Kinetics or enzyme action-effect of substrate concentration (Calculation of M), temperature (calculation of energy of activation).
- 9) Enzyme concentration and pH on enzyme activity.
- 10) Determination of AChE activity in brain.
- 11) Paper chromatography of sugars and amino acids – column chromatography of separation of amino acids.
- 12) Paper electrophoresis of proteins.
- 13) Colour reactions of urine composition.

Semester- II	22ZOOE25-1 ENTOMOLOGY	CREDITS: 4 HOURS: 4
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COURSE OBJECTIVES

- 1) To learn various insects and their classification
- 2) To learn the morphological, anatomical and physiological systems in insects
- 3) To learn knowledge in agricultural entomology as well as beneficial insects
- 4) To learn vector insects and their role in public health
- 5) To learn knowledge on pest management

UNIT - I: Insect Morphology

Insect taxonomy up to orders – Salient features with suitable examples of the insect orders – Thysanura, Odonata, Isoptera, Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Hymenoptera and Diptera – Insects collection – Preservation – Identification – insect head – types of antennae – mouth parts and wing venation – Abdomen.

UNIT - II: Insect Physiology

Structure and Physiology of integumentary, Digestive system: Foregut, Midgut, Hindgut, Salivary gland and Physiology of digestion.

Circulatory system: Components of Circulatory system, Haemocoel – Haemolymph – types of haemocytes.

Excretory system: Types of excretory organs – accessory excretory organs – Physiology of excretion.

Reproductive system: Male reproductive system, Testis – Vasa deferens – Seminal vesicle – accessory glands and Female excretory system – Ovaries – Ovarirole – types- oviduct – spermatheca.

Respiratory system: Trachea – Spiracles – types – terrestrial respiration – Aquatic respiration – Endoparasitic respiration

UNIT - III: Agricultural Entomology

Insect pest – pest outbreak – assessment of insect population – Identification, seasonal history, biology, nature of damage and control measures of major pests of paddy, sugarcane, Vegetables (Brinjal).

UNIT - IV: Principles and methods of Pest Management

Principles of Insect control – Prophylactic measures – cultural, mechanical, physical methods – Genetic control and quarantine. Biological control: parasitoids, Predators and Microbial agents. Chemical methods: Pesticides – general classification – classification based on mode of action and mode of entry Biopesticides: Integrated Pest Management (IPM) – definition, Integration of methods – potential components – need for IPM and uses.

UNIT - V: Beneficial insects and Vector insects

Sericulture: Biology of silk worm, silk gland, cultivation of mulberry plants, rearing of silkworm and uses of silk – Apiculture: types of bees, bee colony, life

history, Structural adaptations – Social organization – Beekeeping accessories – composition of honey and uses of honey– Biology and control measures of important insect vector–mosquitoes.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Identify insects based on morphological features
- 2) Start entrepreneurial activities in sericulture and apiculture
- 3) Take up jobs in vector control and public health departments
- 4) Take up integrated pest management activities
- 5) Understand the Beneficial Insects and Vector insects

Text Books

1. Chapman, F., S.J. Simpson and A.E. Douglas. (2017). *The Insects Structure and Function*, Cambridge University Press, Cambridge.
2. Temphare D.B. (1984). *A Text Book of Insect Morphology, Physiology and Endocrinology*. S. Chand and Co., New Delhi.
3. Chapman R.F. (1982). *The Insect Structure and Functions*. English Language Book society, Harvard University Press, USA.
4. Temphare, D.B. (2011). *Modern Entomology*, Himalaya publishing, Mumbai.

Supplementary Readings

1. Ganga, G. and J. Sulochana Chetty. (2019). *Introduction to Sericulture*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
2. Jayashree, K.V., C.S. Tharadevi and N. Arumugam. (2014). *Apiculture*. Saras, Nagercoil, Tamil Nadu.
3. Prasad, T.V. (2019). *Handbook of Entomology*. New Vishal Publications, New Delhi.
4. Sharma, A.K. (2012). *Anatomy and Physiology of Insects*. Oxford Book Company, New Delhi.
5. Vasantharaj David, B. and V.V. Ramamurthy. (2016). *Elements of Economic Entomology*. Brillion Publishing, New Delhi.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	2	3	3	3
CO3	3	3	2	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	3

Semester- II	22ZOOE25-2: BIOPHYSICS & BIOSTATISTICS	CREDITS: 4 HOURS: 4
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COURSE OBJECTIVES

- 1) To make the students, operate various microscopes.
- 2) To make the students, understand spectroscopic principle and application
- 3) To make the students, know various bio-molecule separation techniques.
- 4) To make the students to understand the Data collection and its classification
- 5) To make the students to understand statistical tools and its application

UNIT - I: Microscopy

Principles, construction and biological use of Compound Microscope, Phase contrast, fluorescence, scanning and transmission electron microscopes.

UNIT - II: Spectroscopy

Absorption and Emission principles – Principles and applications of UV-visible, Spectrofluorometer, flame photometer, Atomic Absorption and Emission spectrophotometers, NMR and Mass spectrometer.

UNIT - III: Chromatography & Electrophoresis

Principles and Application of Chromatography: Paper, Thin layer, column, Ion Exchange, Gel filtration, Gas Liquid, HPLC and affinity chromatography. Principles and Application of Electrophoresis: AGE, PAGE, 2D gel and Iso-Electric focusing.

UNIT - IV: Data Collection, Classification and Descriptive Measures

Collection, classification and tabulation of biological data – diagrammatic and Graphical representations, Measures of central tendency – mean, median, mode, Merit, Demerits – Measures of Dispersion – Standard deviation, Standard error, Merit, Demerits – Coefficient of variation.

UNIT V: Hypothesis Testing

Hypothesis – types-errors in hypothesis testing – significance levels–one tailed and two tailed – Hypothesis testing of Correlation and Regression, Students t' test – Chi-square test – Analysis of variance – types – calculation of One way ANOVA.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Understand the Various types of Microscopes.
- 2) Understand the working principles and application of Spectroscopy
- 3) Understand the principles and application of Electrophoresis and separation Techniques
- 4) Recognize the SEM, TEM, techniques
- 5) Understand and apply the data collection and analysis

Text Books

1. Gupta, S.P. (1988). *An Easy Approach to Statistics*. Chand & Co., New Delhi.
2. Gurumani, N. 2006. *Research Methodology for Biological Sciences*. MJP Publishers, Chennai.
3. Veerakumari, L. 2006. *Bioinstrumentation*. MJP Publishers, Chennai.

Supplementary Readings

1. Daniel, M. (1989). *Basic Biophysics for Biologists*. Agro-Botanical Publishers, India.
2. Ewing, G.W. (1988). *Instrumental Methods of Chemical Analysis*, McGraw Hill Book Company.
3. Milton, J.S. 1992. *Statistical Methods in Biological and Health Sciences*. McGraw Hill Inc., New York.
4. Palanichamy, S. and M. Shanmugavelu. (1997). *Research Methods in Biological Sciences*. Palani Paramount Publications, Tamil Nadu, India.
5. Skoog, A., J.Douglas and J.J. Leary. (1992). *Principles of Instrumental Analysis*. Sanders Golden Sunberst Series, Philadelphia.
6. Wilson, K. and J. Walker. (Eds). (2000). *Practical Biochemistry: Principles and Techniques*. Cambridge Univ. Press, Cambridge.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3
CO2	3	3	3	3	2
CO3	3	3	2	3	3
CO4	3	2	3	3	3
CO5	2	3	3	2	3

Semester- II	22ZOOE25-3: VERMITECHNOLOGY	CREDITS: 4 HOURS: 4
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COURSE OBJECTIVES

- 1) To understand the knowledge of Earthworms and their biological diversity and importance
- 2) To gain the principals and applications of vermitechnology and their application techniques
- 3) To identify the different methods of Composts and their benefits in agriculture fields
- 4) To understand the significant of vermitecholgy and their impacts.
- 5) To Understand the role of earthworms on the decomposition process

UNIT - I

Earthworms and their environment, diversity, distribution and biology – Nature of earthworms soil environment – basic environmental requirements – Food and digestive capabilities, respiratory requirements and adaptation – Systematic affinities and evolutionary descent, classification of earthworms – Niche distribution – Life cycle, behaviour patterns, water relationships, regeneration and transpiration.

UNIT - II

Role of earthworms in soil structure, fertility and productivity – Earthworms burrows and casts – Transformations of carbon, nitrogen and phosphorous – Earthworms as bioindicators of soil types – Effect of earthworms on plant productivity – Earthworms in land amelioration and reclamation. Earthworms as indicators of environmental contamination.

UNIT - III

Earthworms in organic waste management – sewage sludge by earthworms. Management of animal, vegetable and industrial organic waste by earthworms – Earthworm composts as plant growth promoter and its marketing – The use of earthworm as food protein source for animals – Role of earthworms in processing organic wastes applied to agricultural land.

UNIT - IV

Effects of different agricultural practices and their impact on earthworms – The effects of pesticides, fertilizers, Chemicals and Radio isotopes and plastic wastes.

UNIT - V

Earthworms and microorganisms and field sampling methods – The effects of earthworms on the number, biomass and activity of microorganisms – Importance of microorganisms as food for earthworms – Dispersal of microorganisms earthworms. Role of intestinal microbes of earthworms on the decomposition of organic wastes.

COURSE OUTCOMES

At the end of the course, the student will be able to

- 1) Gained the theoretical as well as practical knowledge in the field of and Vermiculture practices
- 2) Interpret the Modern concepts and their application
- 3) Appreciate the biological – soil elements in the behavior of various Earthworm Composts and their significance
- 4) Understand the impact of soil reclamations in various case studies
- 5) Understand the effects of earthworms on the number, biomass and activity of microorganisms

Text Books

1. Bhatt, J.V. and S.R. Khambata. (1959), *Role of Earthworms in Agriculture*, Indian Council of Agricultural Research, New Delhi.
2. Christy, M.V.A. (2015), *Vermitechnology*, Kindle Edition.
3. Edwards, C.A. and B. Bother. (1996). *Biology of Earthworms*, Chapman Hall Publ. Company, London.
4. Edwards, C.A., N.Q. Arancon and R. Sherman. (2011). *Vermiculture Technology: Earthworms, Organic Wastes and Environmental Management*, CRC Press, Boca Raton, FL.
5. Edwards, C.A. and P.J. Bohlen. (1996). *Biology and Ecology of Earthworms*, III Ed. Chapman & Hall, New York.
6. Edwards, C.A. and J.R. Lofty. (1997). *Vermiculture – The Biology of Earthworm*, Chapman & Hall Publications New York.
7. Ismail, S.A. (1997). *Vermitechnology: The Biology of Earthworm*. Orient Longman.
8. Ismail, S.A. (2005). *The Earthworm Book*. Second Revised Edition, Other India Press, Apusa, Goa, India.
9. Lee, K.E. (1985). *Earthworms their Ecology and Relationships with Soils and Land Use*. Academic Press, Sydney.
10. National Institute of Industrial Research. (2010). *The Complete Technology Book on Vermiculture and Vermicompost*, National Institute of Industrial Research, Delhi India.
11. Parthasarathi, K. (2019). *Earthworm Resources Waste Management Pharmacology and Organic Forming. Organic forming using Vermibiotechnology*. Scholars Press, Mauritius.
12. Renganathan, L.S. (2006). *Vermibiotechnology from Soil Health to Human Health*, Agrobios, India.
13. Satchel, J.E. (1983). *Earthworm Ecology*, Chapman Hall, London.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	3
CO3	3	2	3	3	3
CO4	2	3	3	3	3
CO5	3	2	3	2	3