BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

M.Sc. ZOOLOGY: CHOICE BASED CREDIT SYSTEM -
LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

Sem.	Courses	Title	Ins. Hrs	Credit	Exams Hrs	Marks		Total
							Ext	
I	Core Course I (CC)	Structure and Function of Invertebrates	6	5	3	25	75	100
	Core Course II (CC)	Comparative Anatomy of Vertebrates	6	5	3	25	75	100
	Core Choice Course I (CCC) (Any one choice)	1. Molecular Genetics 2. Endocrinology	6	5	3	25	75	100
	Core Practical I (CP)	Structure and Function of Invertebrates and Comparative Anatomy of Vertebrates	6	3	3	40	60	100
	Elective Course I (EC) (Any one choice)	1. Applied Biotechnology 2. Entomology	6	4	3	25	75	100
	Value Added Course I (VAC)	Ornamental Fish culture	-	2*	3	25	75	100*
		Total	**30**	**22**	**-**	**-**	**-**	**500**
II	Core Course III (CC)	Developmental Biology	6	5	3	25	75	100
	Core Course IV (CC)	Cell and Molecular Biology	5	5	3	25	75	100
	Core Choice Course II (CCC) (Any one choice)	1. Environmental Biology 2. Research Methodology and Techniques in biology	5	5	3	25	75	100
	Core Practical II (CP)	Developmental Biology and Cell and Molecular Biology	6	3	3	40	60	100
	Elective Course II (EC) (Any one choice)	1. Wildlife Biology 2. Aquaculture	5	4	3	25	75	100
	Non-Major Elective Course I	Apiculture	3	2	3	25	75	100
		Total	**30**	**24**	**-**	**-**	**-**	**600**
III	Core Course V (CC)	Biochemistry	6	5	3	25	75	100
	Core Course VI (CC)	Comparative Animal Physiology	5	5	3	25	75	100
	Core Choice Course III (CCC)	1. Microbiology 2. Reproductive biology	5	5	3	25	75	100
	Core Practical III (CP)	Comparative Animal Physiology and Biochemistry	6	3	3	40	60	100
	Elective Course III (EC)	1. Computational Biology, Bioinformatics and Biostatistics 2. Sericulture	5	4	3	25	75	100
	Non-Major Elective Course II	Poultry farming	3	2	3	25	75	100
		Total	**30**	**24**	**-**	**-**	**-**	**600**
IV	Core Course VII (CC)	Immunology	6	5	3	25	75	100
	Core Course VIII (CC)	Evolution	6	5	3	25	75	100
	Entrepreneurship / Industry Based Course	Vermitechnology	6	5	3	25	75	100
	Project		12	5	-	20	80	100
	Value Added Course II (VAC)	Nanobiotechnology	-	2*	3	25	75	100*
		TOTAL	**30**	**20**	**-**	**-**	**-**	**400**
GRAND TOTAL			**120**	**90**	**-**	**-**	**-**	**2100**

***The value added courses credit will not be included in the total CGPA.**
These courses are extra-credit courses.
Instruction hours for these courses is 30 hours.

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

Sl. No.	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	Core Courses	8	40	800
2.	Core Choice Courses	3	15	300
3.	Core Practicals	3	9	300
4.	Elective Courses	3	12	300
5.	Entrepreneurship/ Industry Based Course	1	5	100
6.	Project	1	5	100
7.	Non-Major Elective Courses	2	4	200
	Total	**21**	**90**	**2100**
	Value Added Courses *	2*	4*	200*

PROGRAMME OBJECTIVE:

The students will be able to:

- Demonstrate (i) advanced and systematic knowledge in field of biological sciences, specifically in the domain of animal system, and inter disciplinary subjects; (ii) qualified to pursue their career in research and development, teaching, and government and public service; (iii) technical skills in specialized areas to face the challenges in current developments in the field of biological sciences.
- Hone higher order thinking skills required for identifying and relating problems and issues in Life Sciences.
- Integrate knowledge in across the biological science discipline and incorporate into the existing conceptual frame work.
- Communicate effectively in multiple forms, including oral, written and electronic format.
- Meet one's own learning needs, drawing on a range of current research and development work and professional materials.
- Able to design conceptual models and explain the advantage/ disadvantage to address the biological questions.
- Apply the process of science in evidence-based, formal observation with critical thinking and testing with experimentations.
- Demonstrate subject-related and transferable skills that are relevant to Life Sciences related job trades and employment opportunities.
- Able to work precisely in future careers in agriculture, biotechnology, health sciences, environmental management, teaching, and research.
- Able to apply the principles of physical/ chemical sciences and other related disciplines to test hypothesis in biological sciences.
- Apply their knowledge in global perspectives in an ethical manner to sustainable environment/ development in human society.

PROGRAMME OUTCOME:

At the successful completion of programme, the students will be able to:

- Understand inter-disciplinary subjects and their wide range of applicability in research.
- Demonstrate integrative thinking ability to apply critically and analyse to solve biological problems.
- Describe the characteristics of major taxa, differences/similarities in their anatomical, physiological characteristics, and adaptation to their habitat.
- Demonstrate comprehensive knowledge in across the discipline at varying scales from Ecosystem to Molecules (diversity-evolution-structure and function-information exchange/flow – pathways and transformations of signals/energy).
- Apply the scientific methods to design and conduct biological research.
- Demonstrate knowledge and application of broad-based concepts in an interdisciplinary framework in unifying them in biology.
- Describe the safety procedures of handling the instruments, chemicals, microorganism, body fluids and other biological samples.
- Become eligible eventual employment in teaching and/or research positions in academia, industry, government, or non-profit agencies.

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First Year **CORE COURSE I** **Semester I**

STRUCTURE AND FUNCTION OF INVERTEBRATES

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To familiarize with the basis of the taxonomic classification of species.
- To make them relate to the diverse physiology of invertebrates.
- To provide the importance to understand the larval form of invertebrates.
- To signify the role of minor phyla and its significance.
- To impart the significance of organization and evolution of coelom with examples.

UNIT – I TAXONOMY:

Principles of taxonomy -general characteristics and classification of animal Kingdom (up to order). Species concept – taxonomy. International Code of Zoological Nomenclature (ICZN) – taxonomic principles and procedures. New trends in taxonomy -animal collection- Molecular taxonomy and application of bioinformatics tools - handling and preservation. - Organization of coelom - symmetry - embryogeny.

UNIT – II LOCOMOTION, NUTRITION AND DIGESTION:

Pseudopodia - flagella and ciliary movement in Protozoa - hydrostatic movement in Coelenterata, Annelida and Echinodermata. Nutrition and digestion - patterns of feeding and digestion in lower metazoan - filter feeding in Polychaetes, Mollusca and Echinodermata.

UNIT – III RESPIRATION, EXCRETION AND OSMOREGULATION:

Organs of respiration - gills - lungs and trachea. Respiratory pigments - mechanism of respiration. Excretion - organs of excretion - coelom -coelomoducts - nephridia and Malphigian tubules - mechanisms of excretion - excretion and osmoregulation – body fluids.

UNIT – IV NERVOUS SYSTEM AND ITS EVOLUTION:

Primitive nervous system - Coelenterata and Echinodermata -advanced nervous system - Annelida - Arthropoda (Class - Crustacea and Insecta) and Mollusca (Class - Cephalopoda). Trends in neuro-evolution -evolution of nervous system in Invertebrates

UNIT – V INVERTEBRATE LARVAE AND MINOR PHYLA:

Larval forms of free-living Invertebrates -larval forms of parasites -strategies and evolutionary significance of larval forms. Minor phyla -organization - general characters and structural features -Rotifera -Chaetognatha -Ectoprocta - Endoprocta and Phoronida – affinities and significance.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Advanced detecting tools- acoustic and vibration sensing - hyperspectral imaging systems-Dohron scenario of Invertebrates-water expulsion vesicles in Protozoa – Protostomia-Deuterostomia. Biologically inspired learning as a model for intelligent robot control and sensing technology.

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19. Russel-Hunter, W.D. (1969). A biology of Higher Invertebrates. Macmillan Co. Ltd., London.
20. Read, C.P (1972). Animal Parasitism. Prentice Hall Inc., New Jersey.
21. https://www.uou.ac.in/sites/default/files/slm/MSCZO-501.pdf
22. https://www.pdfdrive.com/biosystematics-structure-and-functions-of-invertebrates-e34328227.html
23. http://assets.vmou.ac.in/MZO01.pdf

24. https://adventisteducationbydesign.com/wp-content/themes/bydesign/assets/downloads/sample_lessons/student_editions/KH_BD1_SEG7_U1C2_Lesson_1_sample.pdf
25. https://pdflife.one/download/4660813-biology-form-and-function-in-invertebrates-answers
26. https://www.researchgate.net/profile/Huajian-Liu-3/publication/307529800_A_review_of_recent_sensing_technologies_to_detect_invertebrates_on_crops/links/5c0faab1299bf139c7509a61/A-review-of-recent-sensing-technologies-to-detect-invertebrates-on-crops.pdf
27. https://www.google.com/search?q=trends+in+neural+evolution+in+invertebrates&biw=1252&bih=589&sxsrf=ALiCzsb8PT14ZOnDinR-tY-VmnwhmG-TbQ%3A1655720292131&ei=ZEmwYrjZB5ubseMPjNqE-AE&oq=Trends+in+neural+evolution&gs_lcp=Cgdnd3Mtd2l6EAEYADIKCAAQgAQQhwIQFDIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyBggAEB4QFjoHCAAQRxCwA0oECEEYAEoECEYYAFC4BFi4BGDMGmgBcAF4AIABwgSIAcIEkgEDNS0xmAEAoAECoAEByAEIwAEB&sclient=gws-wiz
28. https://infinitylearn.com/surge/biology/difference-between-protostomes-and-deuterostomes/
29. https://www.researchgate.net/publication/11355321_Robots_in_invertebrate_neuroscience

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Classify the animal species based on the characteristic features.
- Identify the behavior pattern of various invertebrates.
- Explain the similarities and differences in the morphology of organs in a functional view.
- Describe and signify the role of larval forms of invertebrates in the ecosystem.
- Understand the concept of regulation among species.

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First Year **CORE COURSE II** **Semester I**

COMPARATIVE ANATOMY OF VERTEBRATES

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To incorporate the comparative morphology and functional anatomy of vertebrates.
- To make them understand the role of organs and their regulation in secretion during feeding and stimulation in sensory response.
- To compare studies about circulation and respiration in vertebrate animals.
- To study the sense organs and nervous systems of vertebrates.
- To know about the skeletal system and urinogenital system of vertebrates.

UNIT – I PROTOCHORDATES AND CHORDATES:

General characters - significance and evolution -classification of Protochordata. Origin of chordates and classification -nature of vertebrate morphology –definition - scope and relation to other disciplines - importance of vertebrate morphology.

UNIT – II INTEGUMENTARY SYSTEM AND DIGESTIVE SYSTEM:

Origin and classification of vertebrates -integumentary system - derivatives of integument - development - structure -function -skin and its derivatives, - glands -scales - horns - claws -hoofs - feathers - hairs. Digestive system - comparative account of digestive system- anatomy of gut in relation to feeding habits- herbivores - carnivores - omnivores.

UNIT – III CIRCULATORY SYSTEM AND RESPIRATORY SYSTEM:

Circulatory system of vertebrates - general plan of circulation- blood - evolution of heart - evolution of aortic arches and portal systems. Respiratory system - comparative account on respiratory organs – gills and lungs in fishes - skin, gills and lungs in amphibians - air sacs in birds – lungs in mammals.

UNIT – IV NERVOUS SYSTEM AND SENSORY ORGANS:

Nervous system - comparative anatomy of brain –Fish –Frog – Calotes - Pigeon – Rat. Anatomy of spinal cord –nerves – cranial -peripheral and autonomous nervous system. Sensory organs - organs of vision -auditory- olfaction and gustatory- lateral line system.

UNIT – V SKELETAL SYSTEM AND URINOGENITAL SYSTEM:

Skeletal system –form - function - body size -skeletal elements of body - comparative account of jaw suspension - vertebral column - girdles and limbs. Urinogenital system - evolution of urinogenital system (nephron) in vertebrate groups.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Vertebrate fossils - Palaeospondylus -long-standing mystery of vertebrate evolution-Lamprey as a simple vertebrate evolutionary model –Physostomous – Physoclistous. Odorant receptors - Tas1r-expressing taste cells and taste attraction-Tas2r-expressing taste cells and avoidance.

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26. https://fas.calendar.utoronto.ca/course/eeb266h1 (Toronto University, Canada).
27. https://www.syllabusfinder.com/university-of-toronto/eeb263-comparative-vertebrate-anatomy-fall-2014 (Toronto University, Canada)
28. https://www.syllabusfinder.com/static/syllabus/EEB263-Comparative-Vertebrate-Anatomy-Fall-2014.pdf(Toronto University, Canada)
29. https://www.eurekalert.org/news-releases/953666
30. http://ppup.ac.in/download/econtent/pdf/JNL%20College%20(%20Medhavi%20Sudarshan%20for%20Zoology%20B.Sc%20Part%20II%20Paper%20IV)%20Topic-Comparative%20anatomy%20of%20Resperitory%20system%20different%20Vertebrates.pdf
31. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3594521/

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the morphology and functional anatomy of chordates.
- Relate the comparative anatomy of vertebrate integument and digestive system according to their habit and habitat.
- Analyze the integration of physiology of circulation and respiration in Vertebrates.
- Compare the distinct organ structure of vision, hearing, olfaction, taste, etc.,
- Gain detailed knowledge about the complexity of the skeletal and urinogenital systems in vertebrates.

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First Year **CORE CHOICE COURSE I** **Semester I**

1) MOLECULAR GENETICS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To enlighten the structure of genes in Prokaryotes and Eukaryotes.
- To make them understand the molecular structure of gene expression and its regulation.
- To develop a comprehensive understanding of DNA techniques.
- To provide extensive knowledge on DNA sequencing and genomic library.
- To impart in-depth knowledge on gene transfer techniques and gene therapy.

UNIT – I IDENTIFICATION OF GENETIC MATERIAL:

Introduction - fine structure of gene – cistron - muton - recon - exon - intron. Multigene families – types – simple and complex multigene. Regulation of gene expression in prokaryotes – Lac operon -Tryptophan operon of bacteria. Regulation of gene expression in eukaryotes – gene clustering -mechanism of positive and negative control of gene expression. Genetic code– decoding of gene control – alphabets of the code (triplet codon) - coding dictionary – Wobble base pairing -translational and transcriptional control of gene expression. Environmental effects of gene regulation and epigenetics.

UNIT – II STRUCTURE AND FUNCTION OF GENETIC MATERIAL:

Genome organization -nucleus and mitochondria -structure of DNA and RNA - stereochemistry of bases and secondary structures. Genetic structure analyses of eukaryotic genomes -chromatin structure and nucleosome concept. Organization and function of genetic materials -gene paradox -repetitive DNA-satellite DNA -overlapping genes -split genes-pseudogenes.

UNIT – III TECHNIQUES OF MOLECULAR GENETICS:

Recombinant DNA techniques –introduction -restriction modification systems – enzymes in recombinant DNA technology -restriction maps and mapping techniques – nucleic acid probes – blotting techniques – DNA finger printing – foot printing – methyl interference assay – polymerase chain reaction – methods and applications.

UNIT – IV PRINCIPLES OF DNA TECHNOLOGY:

Principles of DNA sequencing -manipulation of genes in animals -automated sequencing methods - synthesis of oligonucleotides – primer design - micro arrays – construction of genomic and cDNA libraries. Strategies of expressing cloned genes - phage display.

UNIT – V GENE MANIPULATION AND PHARMACOGENOMICS:

Gene transfer to animals – transgenic technology – genetically modified organisms – gene knock outs – gene silencing. Gene therapy -somatic - germ line - stem cell and micro RNA therapy. Concept of Pharmacogenomics – use of pharmocogenetics for disease diagnosis and treatment.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Regulation of gene and expression -genetic materials DNA techniques -role of non-coding RNA-CRISPR-Cas mediated gene repairing mechanism-conservation of animals by DNA detection tools – model organisms in genetics.

REFERENCES:

1. Read, A. P. and Strachan, T. (2019). Human Molecular Genetics. United Kingdom: CRC Press, Taylor & Francis Group.
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15. https://www.science.org/doi/10.1126/sciadv.abm9106
16. https://www.genengnews.com/topics/omics/new-insights-into-long-non-coding-rna-and-neuronal-development-revealed/
17. https://news.ufl.edu/2022/05/sea-turtle-edna/
18. https://www.nature.com/articles/s41576-019-0196-1
19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2014592/

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Comprehend the ultra-structure of a gene.
- Acquire wide knowledge of the organization of genome.
- Learn the techniques and tools in molecular genetics.
- Gain knowledge on DNA sequencing and construction of genomic library.
- Understand the techniques in construction of transgenic organisms and pharmacogenomics.

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First Year **CORE CHOICE COURSE I** **Semester I**

2) ENDOCRINOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To highlight the role of hormones and their classification.
- To provide a thorough knowledge of endocrine glands and their neurosecretion.
- To provide the chemical structure of peptide and steroid hormones.
- To understand hormonal action and its regulation.
- To enrich knowledge and applications of hormones in therapy.

UNIT – I INTRODUCTION TO ENDOCRINOLOGY:

Scope of endocrinology - objectives -hormones as chemical messengers – classification – mechanism of hormone actions – feedback mechanism – hypothalamus – neuroendocrine system in Insects and Crustaceans. Hormonal control of reproduction –metamorphosis and moulting–pheromones.

UNIT – II ENDOCRINE ORGANS:

Structural organization – biosynthesis of hormones -targeted organs – functions – abnormalities of thyroid -parathyroid -pancreas -adrenal -testis -ovary -placenta. Role of hormones in sexual cycle – menopause – pregnancy - parturition – lactation – role of prostaglandins.

Unit – III Structure of protein and steroid hormones:

Purification and characterization of hormones – structure – functional relationship. Phylogenic analysis of hormonal structure and function. Biosynthesis of hormones - storage -secretion of hormones – molecular mechanisms of regulation - transcriptional and post transcriptional mechanisms of hormone biosynthesis and secretion. Regulation of biosynthesis and secretion – inhibitors.

UNIT – IV HORMONAL EFFECTS AND ACTIONS:

Discovery of receptors in target tissues - mechanisms of hormone action and signal attenuation – signal discrimination – signal transduction and amplification. Hormone – receptor interactions - receptor antagonists and their applications. Metabolism of hormones by target and non-target tissues – hormones and behaviour.

UNIT – V HORMONES AS THERAPEUTIC AGENTS:

Current developments in design and production of hormonal contraceptives – recombinant protein hormones – production -applications in regulation of fertility in farm animals and humans – Hormones Replacement Therapy (HRT) -genetic engineering for commercial production of insulin. Hormone Assays- Follicle Stimulating Hormone (FSH)- Thyroid stimulating Hormone (TSH).

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Unraveling mechanisms of hormones and sex chromosomes in DNA damage-novel tools for treating Late-Onset Hypogonadism (LOH) syndrome-Wnt/β-Catenin pathway in uterine leiomyoma- mechanistic target of the rapamycin (mTOR) signaling in healthy physiology and disease – emerging endocrine disrupting chemicals.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the basics and scope of endocrinology.
- Know the structure and functions of endocrine glands and their regulation.
- Comprehend the structural and functional roles of hormones in signal transduction.
- Learn the importance of receptor sites and hormonal actions.
- Get deep knowledge of hormones in reproduction and its assisted techniques.

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First Year **CORE PRACTICAL I** **Semester I**

STRUCTURE AND FUNCTION OF INVERTEBRATES AND COMPARATIVE ANATOMY OF VERTEBRATES

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

- To impart practical knowledge on the functional aspects of a different system of invertebrates.
- To comprehend the internal organ system of invertebrates.
- To enrich the knowledge of the invertebrate evolution and types of the coelom.
- To highlight various species and their affinities with other phyla and provides an idea on methods of preservation of specimens.
- To relate the comparative study of digestive, nervous, and reproductive systems of vertebrates.
- To reflect the organization of the brain of fish and other vertebrate animals.

STRUCTURE AND FUNCTION OF INVERTEBRATES

Dissections (Virtual mode)

Dissection of digestive, nervous and reproductive system of Pheretima (Earthworm), Penaeus (Prawn), Squilla (Mantis shrimp) and Pila (Apple snail).

Mountings

Mounting of Mouthparts of Lepas (Barnacles), Apis (Honey bee), Periplanata (Cockroach), *Musca domestica* (Housefly), Culex/Aedes (Mosquito). Pedicellaria of Seaurchin (Echinus). Mounting of Radula–Pila (Apple snail).

Identification of Invertebrate animals:

Trypanosoma, Leishmania, Plasmodium, Nereis, Nereis - Parapodium, Peripatus, Sacculina on Crab, Limulus, Sepia, Octopus, Holothuria (Sea cucumber), Echinus (Sea urchin), Asterias (Starfish), Trochophore larva, Veliger larva, Ophiopluteus larva, Echinopluteus larva, Bipinnaria larva. Minor phyla: Rotifera, Chaetognatha, Endoprocta, Ectoprocta.

COMPARATIVE ANATOMY OF VERTEBRATES

Dissections (Virtual mode)

Comparative study of digestive system, nervous system and reproductive system of of Scoliodon, Rana, Calotes, Columbia and Oryctolagus.

Mounting

Placoid scale of Scoliodon.
Brain of Scoliodon/Rattus / Oryctolagus.

Spotters:

1. Prochordates: Branchiostoma (Amphioxus), Balanoglossus and Ascidia.
2. Pisces: Scoliodon, Ray, Echeneis, Hippocampus (Sea horse), Exocoetus, Catla, Labeo (Rohu), Cirrhinus (Mrigal) and Oreochromis (Tilapia).
3. Amphibia: Rana, Tadpole larva, Axolotl larva, Hyla, Salamander, Ichthyophis.
4. Reptilia: *Naja naja*, Viper, Draco, Chamaeleon, Phrynosoma, Sphenodon.
5. Aves: Columbia (Pigeon), Psittacula (Parrot), Alcedo (King fisher), Bubo (Owl), Quill feather.
6. Mammalia: Megaderma (Bat), Loris, Oryctolagus (Rabbit), Rattus (Rat), Echidna, Ornithorhynchus (Duck-billed Platypus).
7. Dentition in Mammals: Cat, Rabbit, Dog, Rat, Horse/Pig/Mole, Squirrel, Cow/sheep/goat, Kangaroo, Opossum, Lemur, Elephant, Monkey and Man.
8. Osteology: Pigeon – Synsacrum, Rabbit – Pectoral and pelvic girdles, Forelimb and hindlimb bones.

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13. Lacey, Lawrence A. (1997). Manual of Techniques in Insect Pathology. Academic Press.
14. Verma, P.S. (2013). A Manual of Practical Zoology of Invertebrates. S. Chand & Company Ltd., New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Comprehend the adaptation and interactions of various species of invertebrates.
- Understand the importance of protozoan and helminth parasites.
- Identify the behavior and significance of various invertebrates and their larval forms.
- Compare the functional morphology and regulation of vertebrates.
- Acquire knowledge about morphological features and ecological significance of minor phyla

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First Year **ELECTIVE COURSE I** **Semester I**

1) APPLIED BIOTECHNOLOGY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To apply experimental techniques to implement high-quality teaching on the basics of biotechnology.
- To render knowledge on scientific research in applied biotechnology with recent highlights.
- To provide ideas and applications of recombinant DNA technology for the betterment of mankind.
- To impart knowledge to students about the impact of biotechnology in various fields of medicine, agriculture, industry, microbial and environmental fields.
- To enrich the students about the available scope and techniques to improve their skills.

UNIT – I MEDICAL BIOTECHNOLOGY:

Applications of rDNA technology in human health - recombinant DNA proteins and their uses - interferons - interleukin - factor VIII - urokinase and tissue plasminogen activator. Recombinant DNA vaccines -hepatitis-B -rabies and FMD Vaccine. Commercial production of penicillin – DNA finger printing - RAPD and RFLP profiling and its use in forensic science.

UNIT – II HYBRIDOMA TECHNOLOGY:

Production and applications of monoclonal and polyclonal antibodies – gene therapy – cell bank – animal bioreactor (silk worm) and molecular pharming. Transgenic animals – transgenic animal model development – transgenic mouse, knockout mice – embryonic stem cell and pronucleus method – transgenic fish - sheep -pig. Bioethics in animal genetic engineering.

UNIT – III AGRICULTURAL BIOTECHNOLOGY:

Genetically Modified Microorganisms (GMOs) – phytoremediation. Bacterial biofertilizers –Rhizobium - Acetobacter - Azospirillum inoculants – nitrogen - phosphate and sulphate fixing mechanisms. Green manuring – Cyanobacterial inoculants – VAM fungi. Benefits of biofertilizers - biopesticides in pest management.

UNIT – IV INDUSTRIAL AND MICROBIAL BIOTECHNOLOGY:

Fermentation technology - Fermentors -selection of microbes -fermentation medium – production of penicillin -vitamin B12 -amino acids and proteases. Production of organic compounds by microbial fermentation – ethanol -citric acid -acetone production. Antibiotics – microbes in commercial production of antibiotics – Single Cell Protein (SCP) production and their advantages.

UNIT – V ENVIRONMENTAL BIOTECHNOLOGY:

Bioremediation – *in-situ* and *ex-situ* bioremediation – use of genetically engineered bacterial strains – bioremediation of dyes – bioremediation in paper and pulp industry. Immobilized culture – bioremediation of heavy metals -mechanism of metal removal – bioremediation of coal waste through VAM fungi – bioremediation of xenobiotics – recycling of industrial effluents using microbes- Biodeterioration.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Applications of rDNA technology in human health - transgenic animals - molecular biology tools (rDNA) that create genetically modified organisms – development of new vaccines and pharmaceuticals - developing diagnostic kits - monitoring devices - new therapeutic approaches–gene therapy - biomining - bioremediation.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the diverse role/applications of rDNA technology in human welfare.
- Analyse the methods of expression of transgenics and their usage.
- Evaluate the role of genetically modified organisms in the sustenance of the green revolution.
- Comprehend the designing of fermentors and the selection of potential microbes used widely in fermentation technology.
- Enrich the knowledge on the usage of suitable microorganisms in in-situ and ex-situ bioremediation techniques.

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First Year **ELECTIVE COURSE I** **Semester I**

2) ENTOMOLOGY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To enrich with basic knowledge of common insect pests.
- To provide an idea on the classification of pests of crops.
- To impart ideas on the ideology behind pest management.
- To provide the importance of biological agents adopted to control pests.
- To enhance the idea on the behavior of insects towards the selective measures.

UNIT – I CLASSIFICATION OF INSECTS:

Introduction - definition - classification of insect- classification of pests based on magnitude of damage - occurrence on crops – types of crop plants -biological success of insects – reasons for the success of insects – pest outbreak – pest resurgence – insects as phyto-pathogenic vectors.

UNIT – II BIONOMICS AND MANAGEMENT:

Introduction - bionomics and management of selected insect pests of crops – pests of paddy -cotton -pulses (green gram and black gram)-vegetables (brinjal and tomato) – fruits (Mango and Citrus). Economic threshold levels - pests of stored products – external and internal feeders. Basic requirements for storage of food grains in godowns -polyphagous insects.

UNIT – III TOOLS OF INSECT PEST MANAGEMENT (IPM):

Introduction - tools of pest management and their integration – legislative - cultural - physical and mechanical methods - pest survey and surveillance - forecasting - types of surveys - remote sensing methods - factors affecting survey. Political - social and legal implications of IPM -pest risk analysis -pesticide risk analysis - cost benefit rations and partial budgeting – case studies of successful IPM programs.

UNIT – IV MANAGEMENT OF BIOLOGICAL AGENTS:

Management with natural enemies -other biological agents -parasites and parasitoids -predators -microbial agents. Conservation of natural enemies – botanical pesticides. Non-conventional methods for managing insect pests– uses of Insect Growth Regulators (IGRs) -repellents -anti-feedants -pheromones - chemo-sterilizers -irradiation -quarantine.

UNIT – V BEHAVIOUR OF INSECTS:

Chronobiology and unusual behaviour - biological rhythm in insects – foraging - reproduction and infestation – periodicity in migration of Locusts – impacts of catastrophic earthquakes on insect communities.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Artificial intelligence for insect behavior-wild pollinator conservation- organic approach- national organic program-*Bacillus thuringiensis* -Pyrethrum-plant volatile organic compounds (PVOC).

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27. https://enveurope.springeropen.com/articles/10.1186/s12302-019-0203-3

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Acquire basic and applied knowledge on the classification of common pests.
- Understand the role and impact of insect pests on crops.
- Get an idea of management tools and strategies for pest management.
- Understand natural enemies and biological agents.
- Know an idea on the chronobiology and its mechanism of insects.

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First Year **VALUE ADDED COURSE I** **Semester I**

ORNAMENTAL FISH CULTURE

Code: **(Theory)** **Credit: *2**

COURSE OBJECTIVES:

- To imply the current status of ornamental fish farming in India.
- To impart knowledge about the ornamental fish trade in the national and international scenario.
- To provide practical knowledge on culturing live feed for ornamental fishes.
- To familiarize concepts and scopes on aquascaping.
- To effectively familiarize on the ornamental fish diseases and its management

UNIT – I INTRODUCTION TO ORNAMENTAL FISHES:

Basics of fish keeping -definition and current scope-state - national -international scenario of ornamental fishery. Different types of aquarium-types of ornamental fishes.

UNIT – II IMPORT AND EXPORT OF ORNAMENTAL FISHES:

World trade of ornamental fishes and export potential -role of MPEDA in ornamental fishes. Import and export of ornamental fishes in India. Varieties of indigenous species - exotic species. Current status of ornamental fish exporters in Tamil Nadu.

UNIT – III VARIETIES OF ORNAMENTAL FISHES AND LIVE FEED CULTURE:

Ornamental fishes of fresh water - brackish water - marine water. Live bearers – egg laying fishes – breeding and rearing. Ornamental shrimp - clown fish. Live feed culture - Artemia – Daphnia - Infusoria (Protozoa and other microorganisms) – bloodworms and micro worms. Formulated and commercial feed-preparation and importance.

UNIT – IV AQUASCAPING AND WATER QUALITY PARAMETERS:

Basics of Aquascaping - aquascaping soil - aquarium plants - propagation methods – aquascaping tools - lighting and aeration. Aquarium accessories and decorative – economically aquascaping using river sand. Water quality management - water filtration system – biological - mechanical -chemical. Types of filters – advantages and uses.

UNIT – V DISEASE MANAGEMENT:

Biosecurity of ornamental fish -identification of ornamental fish diseases and prophylactic measures - parasites of fish - viral diseases - bacterial diseases - fungal diseases - specific syndrome and disease - fish treatment. Physical examination of diseased fish – diagnostic techniques.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Fluorescent transgenic fish - colour enhancement of ornament fish culture -artificial fertilisation of selective breeding -socio-cultural aspects of farming ornament fish culture -unmonitored trade in marine ornamental fishes.

REFERENCES:

1. Dholakia A. D. Daya. (2009). Ornamental Fish Culture and Aquarium Management Publishing House.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Discuss proficiently about the strategies involving in ornamental fish culture.
- Understand the current status of ornamental fish marketing.
- Gain practical knowledge of culturing of live feed.
- Create their own idea on aquascaping technique for the ornamental fish culture maintenance.
- Identify and know the preventive strategies on ornamental fish diseases and management.

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First Year **CORE COURSE III** **Semester II**

DEVELOPMENTAL BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To provide the basic process of early embryonic development.
- To emphasize embryonic organizers, the nature of genetic information during cell differentiation
- To highlight gametogenesis and its regulation.
- To compare the types of eggs, cleavage patterns, and developmental fate.
- To discuss the molecular regulation of organogenesis and regeneration in amphibians and reptiles.
- To relate the role of hormones, the aging process and genetic disorders disrupting normal development.

UNIT – I BASIC CONCEPTS OF DEVELOPMENT:

Introduction - potency - commitment - specification - induction - competence - determination -differentiation. Morphogenetic gradients - cell fate and cell lineages. Stem cells. Genomic equivalence and cytoplasmic determinants. Imprinting. Mutants and transgenics in analysis of development - organizers - classical experiments on organizers.

UNIT – II GAMETOGENESIS AND FERTILIZATION:

Gametogenesis – spermatogenesis – spermiogenesis - structure and types of sperm. Oogenesis – origin and growth of oocyte - maturation of egg - vitellogenesis - types of eggs. Polarity and symmetry of an egg - organization of egg cytoplasm. Fertilization - events of fertilization - acrosome reaction in sperm – egg activation during fertilization - theories of fertilization.

UNIT – III CLEAVAGE, GASTRULATION AND CYTODIFFERENTIATION:

Cleavage - patterns of cleavage -blastula formation - embryonic fields - gastrulation - morphogenetic movements- formation of germ layers - metabolism during gastrulation - activity of gene during gastrulation - gastrulation in frog and chick. Cellular differentiation - cytodifferentiation and chemodifferentiation. Stem cells - totipotency and pluripotency. Embryonic stem cells and their applications.

UNIT – IV ORGANOGENESIS, REGENERATION AND METAMORPHOSIS:

Organogenesis- ectodermal derivatives - formation of central nervous system- development of eye in frog. Mesodermal derivatives - kidney in frog - endodermal derivative - intestine in frog. Regeneration - types of regeneration. Regenerative capacity in the animals – factors influencing regeneration – stimulation and suppression – polarity and gradients. Metamorphosis – types- amphibian metamorphosis- events and hormonal control. Insect metamorphosis -moulting - growth and hormonal control.

UNIT – V HORMONES AND REPRODUCTIVE DISORDERS:

Hormones - hormones role in sexual cycles in mammals- placenta in mammals. Asexual reproduction - Assisted Reproductive Technology (ART) – male infertility – sperm abnormalities. Superovulation – *In vitro* fertilization (IVF) - Intracytoplasmic sperm injection (ICSI) -Gameto intrafallopian transfer (GIFT) – screening for genetic disorders. Surrogacy and ethical issues

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Epifluorescent stereomicroscopy-Visible embryo project (VEP)–Next Generation Internet (NGI) - Complex genetic regulatory circuits - sequence motifs – cell-cell signalling/interactions - Hedgehog and Notch signaling pathways.

REFERENCES:

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Course Outcomes:

Upon successful completion of this course the students would be able to:

- Understand the basic concepts of development.
- Compare the formation of gametes and their molecular regulation.
- Understanding the knowledge of fertilization initiates the cleavage and gastrulation process.
- Integrate organogenesis in frogs and metamorphosis in amphibians and insects.
- Stimulate the functional importance of hormones in aging, infertility, birth control, and superovulation.

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First Year **CORE COURSE IV** **Semester II**

CELL AND MOLECULAR BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To relate the cell structure at the molecular level and impart the functions of prokaryotic and eukaryotic cells.
- To enlighten about the cellular organelles and their functional integrity.
- To impart mechanisms involved in cell communication and signaling using examples.
- To provide students with relevant knowledge, skills, and values in contemporary molecular cell biology.
- To enrich knowledge about cancer/oncogenes, virus-induced cancer, therapies, cellular morphology, and markers.

UNIT – I MEMBRANE ORGANIZATION, CYTOSKELETON AND MICROMETRY:

Molecular organization of cell membrane – models for membrane structure – cell permeability – cell surface differentiation. Role of microtubules - microfilaments and intermediate filaments in cell organization - division and motility. Methods of cell study - micrometry – cell culture methods – cell fractionation technique – cytochemical staining methods – cytophotometry – immunocytochemistry - autoradiography.

UNIT – II MOLECULAR ORGANIZATION OF CELL ORGANELLES:

Mitochondria - molecular organization - energy transduction - oxidative phosphorylation. Structure and functions of golgi bodies - lysosomes - endoplasmic reticulum. Nucleus and chromosomes - nuclear envelope – nuclear pore – nuclear proteins and nucleosome. Structure and function of chromatin - euchromatin and heterochromatin. Structure and function of giant chromosomes - polytene and lamp brush chromosome - significance.

UNIT – III NUCLEIC ACIDS AND THEIR FUNCTIONS:

DNA and RNA – chemical composition - types and functions. Exons – introns - cistrons - recons - mutons– extra chromosomal DNA- overlapping genes - transposable elements. Gene amplifications. Replication of DNA - DNA repair mechanisms. Mechanism of RNA splicing in eukaryotes. Cell cycle - phases of cell cycle - molecular events in cell cycle. Cell division - mitosis and meiosis - significance.

UNIT – IV TRANSCRIPTION AND TRANSLATIONAL EVENTS:

Ribosomes - morphology - ultra-structure - biochemistry and functions. Protein synthesis **-** mechanism of transcription – role of transcription factors – transcription regulators – processing of mRNA. Translation – post translational modifications and control mechanism. Protein sorting and targeting - protein transport - intracellular compartments. Vesicular trafficking in secretary and

endocytic pathways - transport from endoplasmic reticulum through golgi to lysosome and endosome.

UNIT – V CELL COMMUNICATION:

General principles of cell communication- signaling pathways- G-protein linked cell surface receptors - signaling through enzyme-linked cell surface receptors. Biology of cancer cells–characteristics- types of tumors. Apoptosis and its relevance in cancer biology. Oncogenes – biotic and environmental factors inducing cancer.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Methods of cell study – micrometry - molecular approach of cellular and molecular events in cell cycle - biology of cancer cells - cancer cell metabolism - stress responses – applications of endocytoscopy in basic research.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Obtain knowledge of membrane structure and functional organization.
- Understand the ultra-structure and functions of vital cellular organelles and specialized giant chromosomes.
- Compare the intracellular and extracellular responses in the cell cycle, DNA replication, and DNA repair mechanisms.
- Understand the process of gene expression and relay knowledge on molecular mechanisms of protein synthesis.
- Perceive the complexities in membrane transport and cell communications.
- Relate the normal and cancer cells and types of tumor.

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First Year **CORE CHOICE COURSE II** **Semester II**

1) ENVIRONMENTAL BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To provide an idea of biotic and abiotic factors of the environment and its interactions.
- To understand and relate the mechanism of nutrient cycles using examples.
- To make them understand and learn about population ecology and urbanization.
- To relate concepts and evaluate the pollutant levels and their impact on the environment.
- To make them know the importance of wastewater treatment and solid waste management.

UNIT – I INTRODUCTION:

Introduction - scope - abiotic factors -water - soil - light. Biotic factors -intra (aggregation, colony formation and social organization) - inter specific associations (neutralism, symbiosis and antagonism). Ecological and environmental significance of interaction. Ecosystem - structure and function - autotrophic and heterotrophic producers - consumers – ecological pyramids. Primary and secondary productivity - methods of measurements -different trophic level - energy flow in an ecosystem - food chain - food web. Habitat and niche - concept of habitat and niche- niche width and overlap- fundamental and realized niche - characteristics of different biomes. Interaction between environment and biota - energy and nutrient flow.

UNIT – II COMMUNITY ECOLOGY:

Nutrient cycles – nitrogen - phosphorus -carbon and sulphur in nature – (role of microbes in environment: Nitrogen fixing bacteria - Azotobacter, Nostoc: Denitrifying bacteria - *Micrococcus denitrificans, Thiobacillus denitrificans*). Biotic community – nature and structure of community -community concepts – stratification – ecological niches – ecotone and ecological succession. Population ecology and biological control. Population growth – population growth curve – population regulation – life history strategies (r and k selection of species)– biotic potential in regulation of population size – population interaction – human population and urbanization - concept of metapopulation.

UNIT – III HABITAT ECOLOGY AND CONSERVATION:

Biodiversity-basic concepts – types - hot spots of bio diversity. Fresh water - marine - estuary - terrestrial - forest and desert. Biogeography – bio-geographical zones of India. Wildlife conservations and management – international / national policies and conservation strategies of biodiversity management. Remote sensing -satellite images – aerial photography – thermal and infrared images - radar in ecological applications. Instrumentation –Global Position System (GPS) - radio telemetry and satellite telemetry techniques used in ecological research.

Ecoinformatics – concept and principles -applications of ecoinformatics. Geographic information system (GIS) techniques in ecological research.

UNIT – IV ENVIRONMENTAL POLLUTION:

Effects and control measures of air -water -soil -marine pollution -types of pollutants. Principles and instruments for measurements of ambient air pollutants -dispersion of air pollutants. Acid rain and ozone layer depletion. Bio accumulation – bio magnification - Biological Oxygen Demand (BOD) - Oxygen Demand (OD), Chemical Oxygen Demand (COD) - Total Dissolved Solids (TDS) - Total Suspended Solids (TSS) -Total Solids (TS). EIA (Environmental Impact Assessment) – steps – methods of EIA. Wastewater treatment -primary -secondary and advanced treatment methods –common effluent treatment plant. Analysis of soil quality -soil pollution control -industrial effluents and their interactions with soil components. Natural resources - sustainable development – survey. Energy resources - environmental quality standards – soil conservation.

UNIT – V TOXICOLOGY:

Toxicity -types of toxicity - acute toxicity – chronic toxicity – assessment of safety/risk. Mechanism of toxicity. Toxins - types of toxins - pesticide toxicity - pesticides and their types – insecticides – herbicides – fungicides – rodenticides – nematicides – fumigants. Properties and effects of pesticides on organisms – acute and chronic effects - biological monitoring and regulation. Toxicological methods - acute - sub-acute chronic and special tests. Statistical concept of toxicity - concentrations. Response relationship – margin of safety -toxicity curve - cumulative toxicity and toxicity of chemical mixture - LC_{50} and LD_{50} - bioremediation of toxic substances.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Threats of natural resources depletion - climatic changes - deforestation and prevention. Spatial aspects of biodiversity and the homogenization threat to forest ecosystems.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Gain knowledge of different components of ecosystems.
- Obtain practical ideology/knowledge on environmental monitoring software like GIS and GPS.
- Understand the basic ecoinformatics and its role.
- Know the cause and impact of environmental pollution and the steps to control it.
- Be aware on environmental toxins and toxicological screening methods.

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First Year **CORE CHOICE COURSE II** **Semester II**

2) RESEARCH METHODOLOGY AND TECHNIQUES IN BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- Provide detailed information about the research design and data collection.
- Deal with strategies for the preparation of scientific presentations and data analysis.
- Make familiar with the sample preparation for the micrograph techniques.
- Highlight the methods of immunological techniques for medicinal diagnosis.
- Practice them on the handling cell culture techniques, cryopreservation and storage of cell lines.

UNIT – I INTRODUCTION TO RESEARCH:

Concept of scientific research – selection of a research problem – research design – sampling methods – hypothesis testing- null hypothesis- alternate hypothesis- data collection – making observation and records. Preparation of index cards – reference collection and alignment – refereed journals -impact factor -citation index - science direct – H-index. Intellectual Property Rights (IPR) – trademarks and copyright.

UNIT – II PREPARATION OF SCIENTIFIC PRESENTATIONS:

Introduction - preparation of scientific papers for publication in a journal. Preparation and presentation of research paper for symposia -seminar and conferences. Technical papers and monographs. Internet and e-journals. Preparation of thesis – components of thesis. Selection of animal models – maintenance – Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) guidelines. Using computers in research – computer aided techniques for data analysis - data interpretation and presentation. Levels of significance - regression and correlation -plagiarism detecting software and multivariate statistics.

UNIT – III BIOPHYSICAL AND MICROTECHNIQUES:

UV/Visible - Nuclear Magnetic Resonance (NMR) and Electron spin resonance (ESR) spectroscopy -molecular structure determination -X-ray Diffraction (XRD) - functional group identification -Fourier Transform Infra-Red (FT-IR). Chromatographic techniques-Thin layer chromatography (TLC) -Paper chromatography (PC) -Gas chromatography and Mass spectrometry (GC-MS) - High performance liquid chromatography (HPLC). Permanent mounting- narcotization and killing – fixing – washing – processing – staining – mounting – labelling. Histological preparation of tissues for SEM and TEM. Microphotography principles and applications. Detection of molecules in living cells -*in situ* localization by techniques -Fluorescent *in situ* hybridization (FISH) and Genomic *in situ* hybridization (GISH). Cryotechniques for microscopy. Freeze drying for physiologically active substances.

UNIT – IV IMMUNOLOGICAL TECHNIQUES:

Organization of MHC locus (mice and human) -structure and functions of MHC I and II molecules. Antigen and antibody preparation and purification -production of monoclonal antibodies (MABs). Primary and secondary immune response. Immunological techniques in medical diagnosis – HIV – hepatitis A and B – cancer and pregnancy. Electrophoresis techniques – gel electrophoresis –SDS-PAGE – two dimensional gel electrophoresis -Enzyme-linked immunosorbent assay (ELISA) -blotting techniques -immuno-fluoresence -flow cytometry -RT-PCR -Matrix Assisted Laser Desorption/Ionization (MALDI) and N- terminal sequencing.

UNIT – V ANIMAL CELL CULTURE TECHNIQUES:

Design and functioning of tissue culture laboratory – cell proliferation measurements – cell viability testing – culture media preparation. Experimental procedures -types of culture – flask -test tube -organ and embryo culture. Protoplast culture. Stem cell culture. Cryopreservation for cells - tissues - organisms. Application of cell culture- vaccine production- gene therapy. Germplasm storage -Cryobank – pollen bank - sperm bank. Biosensors and biochips – applications.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Research ethics- responsibilities and guidelines. Incorporation of radiolabelling and its applications. Designing of biomaterials for the growth of the cell. 3-D cell culture techniques to identify the detailed morphology of the cell.

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21. https://www.frontiersin.org/articles/10.3389/ftox.2021.753316/full

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the basic concepts of scientific research and the steps to be followed during research.
- Attain knowledge about the preparation and presentation of research outcomes in any scientific forum.
- Perceive the micro techniques for the detection of molecules in living cells.
- Acquire knowledge of antigen-antibody complexes to treat various killer diseases.
- Understand the mechanism of cell proliferation and storage of germplasms.

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First Year **CORE PRACTICAL II** **Semester II**

DEVELOPMENTAL BIOLOGY AND CELL AND MOLECULAR BIOLOGY

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

- To provide practical skills in handling microscopes.
- To train them to handle analytical instruments.
- To enrich the basic skill and ability to prepare chemicals and solvents.
- To make them know the practical skill in observing slides and specimens with required theoretical knowledge.
- To understand the methods to prepare and preserve slides and specimens.

DEVELOPMENTAL BIOLOGY

EXPERIMENTS

1. Preparation of sperm suspension of bull and microscopic observation of spermatozoa.
2. Observation of live spermatozoa and study of rate of motility of sperm in bull' semen.
3. Developmental stages in chick embryo – 24hrs, 48 hrs, 72 hrs and 96 hrs.
4. Vaginal smear preparation in rat / mouse to study the stages of oestrous cycle.
5. Developmental stages of Plankton.

SPOTTERS

1. Developmental stages of *Euphlyctis hexadactylus.*
   a. Fertilized egg stage.
   b. Two, four and eight cell stage.
   c. Blastula and C.S. of blastula stage.
   d. Gastrula and C.S. gastrula stage.
   e. Neural tube and C.S. of neural tube stage.
   f. Tail bud and tadpole stage.
2. Cell aggregation and differentiation in *Dictyostelium discoideum.*
3. Sex determination in *Caenorhabditis elegans.*
4. Predator induced polyphenism in *Daphnia pulex.*

CELL AND MOLECULAR BIOLOGY

EXPERIMENTS

1. Isolation of DNA from animal tissue.
2. Isolation of plasmid DNA from bacteria.
3. Protein estimation by Lowry's method
4. Human buccal smear – Barr body.
5. Blood smear – Cockroach/ Human.
6. Onion root tip - Squash preparation – Different stages of mitosis.
7. Micrometry - Measurement of the size and volume of cells using ocular and stage micrometer.
8. Differential cell count – Human blood sample.
9. Enumeration of RBC and WBC count by using haemocytometer.

SPOTTERS:

Centrifuge – cooling and ultra centrifuge, Autoradiography, Ocular micrometer and Stage micrometer, Giant chromosome, Compound microscope, Models of transposable elements, Carcinogens - Ethidium bromide, Acridine orange, Haemocytometer.
Models: DNA replication, Protein synthesis.

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Course Outcomes:

Upon successful completion of this course the students would be able to:

- Understand the principles involved in the isolation of DNA / plasmid DNA.
- Focus and differentiate the cell morphology and count of blood cells.
- Get practice on methods of cell study.
- Understand the process and gains the skill to prepare slides for different stages of mitosis.
- Gain knowledge and skill to measure the size and volume of cells using ocular and stage micrometers.

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First Year **ELECTIVE COURSE II** **Semester II**

1) WILDLIFE BIOLOGY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To impart knowledge to understand the importance of studying wildlife and its resources.
- To investigate and share the techniques associated with wildlife and habitat assessment and usage of field equipment.
- To highlight the behavior of different wild animals and make them understand their significance.
- To identify and clarify the conflicts associated with wildlife, environmental impact, and mitigation measures.
- To explore and share different conservation measures to be followed for various wildlife threats.

UNIT – I WILDLIFE IN INDIA:

Wildlife -definition -causes of wildlife depletion -economic importance of wildlife - need for wildlife conservation. International Union for Conservation of Nature (IUCN)- threat categories – endangered - threatened. India as a mega wildlife diversity country - endemic species of fishes - amphibians - reptiles - birds - mammals. Forests in India - identification - dendrology. Deforestation and its impacts -forest inventory – Sustainable Forest Management (SFM).

UNIT – II WILDLIFE MANAGEMENT TECHNIQUES:

Habitat manipulation - food - water - shade improvement. Impact and removal of invasive alien species. Making observations -records - field notes and datasheets. Planning census – total counts - sample counts – basic concepts and applications - direct count (transect methods, point counts, visual encounter survey, waterhole survey) -indirect count (call count, track and signs, pellet count, pugmark) - capture - recapture techniques. Wildlife photography - types of cameras - camera traps. Field equipments - binoculars - altimeter - pedometer - field compass. Sound recording and media players - activity recording - weight measurement -radio collaring -Global Positioning Systems (GPS) and Geographic Information Systems (GIS).

UNIT – III ETHOLOGY IN WILDLIFE:

Introduction - instinctive behaviour-classical and modern concepts-fixed action pattern and ritualization. Learning – imprinting-habituation. Analysis of behaviour pattern – taxis - kinesis and reflexes. Methods of studying animal behavior. Biological rhythms and bird migration. Types of animal communications. Optimal Foraging behaviour. Origin and significance of play - courtship - display - sexual selection and parental care in mammals and birds. Social behaviour of elephants and lion.

UNIT – IV HUMAN-WILDLIFE CONFLICTS:

Basic concepts - reason for conflicts -identification of damages caused by wild animals and control measures. Chemical restraints -advantages and disadvantages – case studies – elephant -tiger -leopard. Translocation of wild animals – principles -methods -applications.

UNIT – V CONSERVATION OF WILDLIFE:

Introduction – definition – formation - management and administration -*in-situ* and *ex-situ* conservation -wildlife sanctuaries -national parks -tiger reserves and biosphere reserves. Wildlife Projects -tiger and elephant. Zoos and zoological parks -definition - aims of zoos- formation and management - Central Zoo Authority (CZA)of India. Captive breeding -aims -principles - methods. Role of government and non-governmental organizations in conservation. Overview of Wildlife (Protection) Act, 1972. Eco-restoration and ecotourism programs. Anti-poaching operations.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

IUCN status of wildlife-sonogram analysis of animals - citizen science and wildlife conservation-wildlife trade-wildlife forensics-reintroduction of wild animals.

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28. https://ebird.org/india/home (e-bird data entry)
29. https://www.traffic.org/ (wildlife trade)
30. https://cites.org/eng/prog/imp/Wildlife_forensics (Wildlife Forensics)
31. https://ntca.gov.in/reintroduction/#reintroducing-tigers-2 (Tiger reintroduction)

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Acquire knowledge of wildlife conservation and its importance.
- Understand the basic concepts and applications related to wildlife risk assessment.
- Perceive knowledge of communication behavior in animals.
- Recognize the wildlife damages and its preventive measures.
- Comprehend the importance /role of reserves and zoological parks in wildlife conservation.

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First Year **ELECTIVE COURSE II** **Semester II**

2) AQUACULTURE

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To impart knowledge on the current status, scope and importance of aquaculture in India.
- To provide information about types of freshwater aquaculture.
- To comprehend sea farming and mariculture practices in India.
- To relate the impact of diseases in production and their management.
- To elucidate the import and export status in India.

UNIT – I INTRODUCTION TO AQUACULTURE:

Aquaculture - introduction – definition -historical patterns and practices. Aquaculture activities -current status - future aquaculture techniques in India. Major cultivable species for aquaculture in India. A knowledge of inland water bodies suitable for culture in India.

UNIT – II FRESHWATER AQUACULTURE:

Different types of freshwater aquaculture -preparation and management of nursery and rearing ponds -use of fertilizers and manures -control of aquatic weeds and algal blooms. Culture of Indian major carps -culture of cold water fishes -culture of freshwater prawns. Recirculatory aquaculture systems - cages and pens.

UNIT – III COASTAL AND MARINE AQUACULTURE:

Biology of cultivable finfish and shellfish –coastal and marine aquaculture. Types of culture - traditional (Pokkali, Bheries) - semi-intensive and intensive culture. Shrimp and fish hatchery and farm management. Cage and pen culture practices in India. Commercially important seaweed species - culture of sea weeds – crab culture.

UNIT – IV BEST MANAGEMENT PRACTICES:

Biosecurity of nursery and rearing ponds - role of abiotic and biotic factors - water quality management. Intrinsic factors - generic - species and strain. Extrinsic factors - environment - nutritional status - role of stress in disease process. Microbial disease -viral - bacterial -fungal diseases and their control. Parasitic diseases and their control.

UNIT – V AQUACULTURE ECONOMICS:

The basis of production -interrelationships of aquaculture systems -fish marketing methods in India. Basic concepts in demand and price analysis - demand - supply and fish prices - elasticity of demand. Export of fishery products

from India and major countries - important products - export documents and procedures.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Recirculating Aquaculture system (RAS)- offshore aquaculture-Biofloc technology-Integrated Multi-Trophic Aquaculture (IMTA)-In-Pond Raceway Systems (IPRS)-sustainable feed management.

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21. https://brill.com/view/book/edcoll/9789004380271/BP000069.xml
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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Proficiently discuss the basics of aquaculture practices.
- Understand the types of aquaculture systems and its significance.
- Differentiate the types of mariculture and its management for various culture systems.
- Gain knowledge on major bacterial, viral, protozoan, and fungal diseases in aquaculture.
- Signify the current status of the fish trade and marketing methodologies in India.

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First Year **NON-MAJOR ELECTIVE I APICULTURE** **Semester II**

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- To enrich knowledge on the history and distribution of honey bees.
- To understand the methods of breeding strategies in honey production.
- To comprehend the application of honey bee products, their economics, and marketing.
- To attain the practical knowledge of becoming an entrepreneur after his/her post-graduation.
- Make them a role to participate in different research organizations and funding agencies to promote apiary.
- To enlighten the students about the role of apiary and its management in the sustenance of environment and mankind.

UNIT – I HISTORY OF APIARY:

Apiary - introduction -definition of beekeeping. Status of bee keeping - India and worldwide. Methods -traditional and modern methods of bee keeping. Origin - systematics and distribution of honeybees -types of honeybee species. Biology and life history - colony polymorphism and dynamics. Communication through dance and its types -foraging types and pattern.

UNIT – II ADAPTATION IN HONEYBEES/HONEY BEE HANDLING:

Introduction – structural-behavioural -ecological -physiological adaptations and their importance. Polyethism in honeybee colony - colony polymorphism and dynamics -queen -workers and drones and their importance. Urban or backyard bee keeping - significance. Equipments for bee keeping - land and building requirements - processing units - transport facilities - hive displacement. Need for raising queens - qualities of good queen - methods of raising queens - natural and artificial methods - Hopkin's method - Alley method - Miller method - Dequeening method -raising queen on double -whole brood comb.

UNIT – III GENERAL MANAGEMENT PRACTICES IN APIARY:

Introduction - identification of bee plants in the apiary location - types of bee pasturage- single year productive - multi-year productive - permanent productive. Improving bee pasture in apiary locality -apiary location - hive placement– densities - precautions in hive placement - hive care and inspection. Swarm management -identification of flow and dearth period - care of colonies during dearth periods - additional feeding - queen care and swarm control - honey extraction in flow season and disease control.

UNIT – IV PESTS AND DISEASE MANAGEMENT:

Introduction – types - insect pests- wax moth - ants - wasps - control of mites- mechanical - chemical - bio pesticide. Bacterial diseases-American foulbrood -

European foulbrood. Viral disease- deforming wing virus -black queen cell virus - acute bee paralysis virus. Fungal diseases- chalk brood -stone brood. Protozoan diseases- Nosemosis. Methods of bee poisoning impact of pesticide on honeybees' health and colony. - Colony Collapse Disorder (CCD) and its global impact on pollination - threats and risks to pollinators and need for conservation.

UNIT – V ECONOMICS AND MARKETING OF HONEYBEE PRODUCTS:

Introduction and characteristics and importance of bee products -nutrients and composition of honey - honeybee products –honey -pollen -royal jelly -bees wax - propolis and bee venom. Economics of apiary -small scale and large scale -value of commercial apiary - labour requirements in apiary management - marketing of hives - marketing of adult and larval bees and trait selected queen.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Steps involved in starting an apiary project-funding sources-fund mobilization in State and National banks-role of National Bee Board (NBB) - Central Bee Research and Training Institute (CBRTI).

REFERENCES:

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18. https://www.thespruce.com/beekeeping-for-beginners-step-by-step-3016540
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20. https://www.researchgate.net/profile/Keith-Delaplane/publication/45801259_Colony_Collapse_Disorder_in_context/links/0912f50b6bdd79d84d000000/Colony-Collapse-Disorder-in-context.pdf?origin=publication_detail
21. https://agritech.tnau.ac.in/farm_enterprises/fe_api_careandmanagement.html
22. https://www.intechopen.com/chapters/69826

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Analyze and understand the history and the status of apiary in India and worldwide.
- Understand the colony polymorphism dynamics and the qualities of a good queen, methods of raising queens.
- Comprehend and evaluate the role of general management practices in the apiary.
- Apply the knowledge about the usage, nutrients and composition of honey and honeybee products.
- Perceive about the pests and disease management system and global impact on pollination.

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Second Year	**CORE COURSE V BIOCHEMISTRY**	**Semester III**
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

- To visualize and discuss the basic structure and function of biomolecules.
- To provide deep knowledge on the metabolism of biomolecules with suitable examples.
- To illustrate the mechanism and importance of enzyme kinetics.
- To highlight thermodynamics and energy transduction of biological systems.
- To perceive using examples about the principle mechanism of catalysis.

UNIT – I Principles of Biochemistry:

Introduction to Biochemistry - structure of atoms - molecules and chemical bonds. Physical and chemical processes of living systems – water and its functions - structure and physicochemical properties of water. Ionization of water – dissolved gases and their properties – pH and buffer. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding and hydrophobic interaction).

UNIT – II Biomolecules:

Introduction - structure - classification and function of carbohydrates - proteins – lipids. Nature and types of bonds in biomolecules. Amino acids -structure and classification – ketogenic and glucogenic amino acids – prostaglandins – classes - functions -pharmacological uses. Vitamins -structure of water soluble and fat-soluble vitamins -deficiency symptoms. Minerals - types – functions - deficiencies - toxicity. Respiratory pigments - structure of hemoglobin and cytochrome. Biological oxidation - nucleotides - flavoproteins - cytochromes – redox potential – oxidative phosphorylation.

UNIT – III Metabolism:

Introduction - metabolism of carbohydrate - glycolysis - TCA cycle - HMP shunt pathway - glycogenesis and glycogenolysis. Protein -general pathway of amino acid metabolism – deamination - transamination and decarboxylation - urea cycle. Catabolism of tyrosine -tryptophan - glycine and phenylalanine. Lipids - beta-oxidation - biosynthesis of saturated fatty acids - palmitic acid. Nucleic acids -metabolism of purine and pyrimidine nucleotides. High energy phosphates and their role in redox reaction. Phosphagens-ATP as an energy molecule -synthesis of ATP. Receptors of hormones- G-protein - ligand gated ion channels (acetyl choline receptor) and aquaporins.

UNIT – IV Thermodynamics and Energetics:

Thermogenesis - definition – laws of thermodynamics - thermodynamics of biological reactions - role of thermodynamics in intermediary metabolism - redox reactions - standard redox potentials. Energetics - relevance of entropy and enthalpy in biological systems. Energy transduction in photosynthesis and cellular respiration.

UNIT - V: Enzyme Kinetics:

Enzymes -classification – properties – 3D structure of an enzyme – mechanism of action of enzymes - active site - lock and key model-induced fit hypothesis. Mechanism of enzyme catalysis - enzyme-substrate complex formation -allosteric enzymes - co-enzymes and its properties - abzymes and synzyme. Hormones - mechanism of hormone action – peptide hormone – adenylatecyclase – cyclic AMP mechanism – Ca^{2+}-phosphoinositol - steroid hormone and transcriptional control. Enzyme kinetics - principles of enzyme kinetics. Michaelis-Menten kinetic equation - Lineweaver-Burk plot - Eadie-Hofstee–Hanes-Woolf plot.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Co-condensation of proteins with single - double-stranded DNA. Use of enzymes to change brain cells in communication. Micro RNA technology. Hormonal imbalance leads to osteoporosis.

REFERENCES:

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16. http://www.freebookcentre.net/medical_text_books_journals/bio_chemistry_microbiology_ebooks_texts_download.html
17. https://teachmephysiology.com/biochemistry/molecules-and-signalling/enzyme-kinetics/
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19. https://www.thoughtco.com/laws-of-thermodynamics-373307
20. https://www.pharmaguideline.com/2022/01/hmp-shunt-and-its-significance.html

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the major interactive forces on biomolecules.
- Explain the metabolism of biomolecules and their functions.
- Highlight the enzymatic role of molecules and their reactions.
- Correlate physiological and biochemical pathways.
- Discuss and solve the thermodynamic principles and problems respectively.

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Second Year **CORE COURSE VI** **Semester III**

COMPARATIVE ANIMAL PHYSIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To enrich knowledge on body functions and adaptations concerning its external and internal environment.
- To differentiate the internal physical and chemical functions related to nervous integration, sensation, metabolism and reproduction.
- To impart knowledge about digestion and excretion, blood and circulatory systems.
- To perceive the mechanism of respiration and the nervous system.
- To relate the regulation of the sensory organs according to the stimuli.
- To ensure basic idea on the reproductive system in the mammal.

UNIT – I Nutritional, Thermal Physiology and Homeostasis:

Introduction - definition and nutrition - food requirements - physiology of ingestion - types of digestion – extra and intracellular. Digestive enzymes and their role - absorption and assimilation of digested food materials - Balanced diet. Thermal physiology - heat transfer mechanism between animal and environment. Supercooling - anti freeze compound - behavioural thermoregulation - Pejus temperature (T_p) - critical temperature - adaptational trend in subzero condition. Homeostatic mechanisms - osmo-ionic regulation in Crustaceans and fishes – temperature and pH regulations in animals. Light – photo biological processes – pressure – acclimatization to high altitudes – hydrostatic pressure – buoyancy.

UNIT – II Respiratory and Circulatory Physiology:

Respiration **-** structure of lungs and gaseous exchange - transport of O_2 and CO_2 – respiratory pigments - Formation of oxyhaemoglobin and affinity of haemoglobin for O_2 and CO_2 dissociation curves - chloride shift - Bohr Effect. Circulation - open and closed circulatory system - structure of heart and its working mechanism – heartbeat and cardiac cycle - ECG. Myogenic and neurogenic hearts. Properties and functions of blood – factors contributing to heart diseases in humans**.**

UNIT – III Excretory and Muscular Physiology:

Excretion - excretory organs of vertebrates – mechanism of excretion – adaptations of excretion to environment. Excretory products - synthesis and elimination - structure and function of nephron and kidney in Mammals – counter current mechanism of urine formation and excretion. Muscles – structure and types of muscles - muscle contraction-theories - sliding filament mechanism. Chemical changes during muscle contraction – role of calcium - ATP utilization and its replenishment.

UNIT – IV Neuronal and Sensory Physiology:

Structure of nerve cell - nature of nerve impulse – resting potential and action potential. Properties of nerve impulse – threshold value - refractory period - all or none response. Conduction of nerve impulse - structure of synapse - mechanism of synaptic transmission – electrical and chemical transmissions - neuro-transmitters - neuro-degenerative diseases. Receptors - types - photoreceptor – structure of human eye and physiology of vision. Phonoreceptor – structure of human ear - organ of Corti- physiology of hearing. Chronobiology - biological rhythms – rhythms in man – biological clock.

UNIT – V Endocrine System/Physiology:

Endocrine glands – relationship between hypothalamus and pituitary gland. Hormones of hypothalamus-adenohypophysis - neurohypophysis. Hormones of pineal gland - thyroid gland - parathyroid - thymus - adrenal - pancreas. Endocrine control of mammalian reproduction – male and female hormones – hormonal control of menstrual and oestrous cycle. Regulatory mechanism-feedback and neuroendocrine regulation. Hormones of insects involved in moulting and metamorphosis.

UNIT-VI: CURRENT CONTOURS (For continuous internal assessment only):

Animal traits databases - fast-scan cyclic voltammetry for neurotransmission in animal models – Ferguson reflex - Cholecystokinin-Hamburger's phenomenon-renin-angiotensin system (RAS) - Hashimoto's Disease - synthetic membrane transport.

REFERENCES:

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17. https://www.nature.com/articles/s41597-022-01364-9
18. https://www.nature.com/articles/d41586-022-01170-8
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20. https://www.researchgate.net/profile/P-Reddy-3/publication/286456096_DrPBReddy%27s_TEXT_BOOK_OF_ANIMAL_PHYSIOLOGY/links/566ae70e08ae430ab4f931bc/DrPBReddys-TEXT-BOOK-OF-ANIMAL-PHYSIOLOGY.pdf?origin=publication_detail
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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand and relation of adaptations and mechanism of homeostasis in Vertebrates.
- Know the importance of nutrients and the controlling process in the regulation of digestion.
- Comprehend the mode of action of circulation, respiration, and excretion.
- Analyze the physiology of effectors, receptors, and neuronal conduction in somatic regulation.
- Perceive the physiology of reproductive organs and apply the techniques for infertility management.

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Second Year **CORE CHOICE COURSE III** **Semester III**

1. MICROBIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To enrich knowledge on the scope and characteristics of microorganisms.
- To make them understand the technology-based microbial incorporation for the benefit of the human.
- To compare environmental-related microbes and their significance.
- To enrich the knowledge about the action mechanism of the microbes in food.
- To provide information about microbial disease management strategies.

UNIT – I Introduction to Microbiology:

History and scope of microbiology - classification of microbes. Structure of a bacterium. Bacterial respiration and reproduction. Bacterial nutrition and growth - nutritional types. Microbial growth requirements - factors affecting microbial growth. Types of culture - culture media - isolation of pure culture – colony morphology and growth - growth curve and growth kinetics – economic importance of bacteria. Classification of viruses - physical and chemical structures of viruses - DNA and RNA viruses.

UNIT – II Microbial Technology:

Genetic engineering of food and additives. Microbial genetics - recombinant technology in bacteria – transformation – conjugation – sex duction. Recombination in bacteriophage – transduction – lytic and lysogenic cycle - Mutations in bacteria - repair mechanism of mutational damage to bacteria - bacterial genome – complexity - gene density and elements - genetic applications of bacteria and viruses - gene therapy and vaccine development.

UNIT – III Environmental Microbiology:

Microorganism of different soils - interactions with the atmosphere. Bioleaching-commercial leaching methods - environmental conditions affecting bacterial leaching. Biofertilizers - Nitrogen fixing (Clostridium sp.) - Phosphate solubilizing (Penicillium sp.) - phosphate mobilizing (Rhizoctonia sp.). Bioremediation and its types. Microorganisms in aquatic habitats – microbiological analysis in fresh water and marine water. Microorganisms and pollution – microorganisms in sewage. Microorganism in extreme environments - thermophiles - mesophiles - psychrophiles - methanogens and halophiles.

UNIT – IV Industrial Microbiology:

Overview of industrially important microbes - important characteristics – fermenter - types of cultivations - extraction of fermentation products. Productions of industrial products – vinegar – Single Cell Protein (SCP) - beer and yeast production. Production of microbial insecticides. Production of organic acids (citric acid and lactic acid) and alcohol (ethanol) - antibiotics (Penicillin and Cephalosporin). Microbes of milk and food - methods of detection - pasteurization

and food poisoning. Spoilage of food - factors influencing spoilage – food preservation. Quality assurance - microbiological quality standards of food - government regulatory practices and policies - Food and Drug Administration (FDA) - Environmental Protection Agency (EPA).

UNIT – V Microbial Disease Management:

Microorganisms and microbial diseases - general account of pathogenic bacteria – prognosis - diagnosis and treatment for diseases - Virus (Measles, rubella, chickenpox, polio, HIV, influenza, COVID-19 and Monkey pox) - Bacteria (Pneumonia, cholera, lyme disease, meningitis, tuberculosis and typhoid) - Fungi (madura foot, athlete's foot, histoplasmosis and candidiasis) and Protozoa (Malaria, amoebic dysentery, trypanosomiasis and leptospirosis).

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Importance of microbial mutation analysis. Inheritance in bacteria - types of mutations -spontaneous and induced mutagenesis - isolating mutants - selecting mutants - mutant enrichment. DNA damage and mechanism- horizontal gene transfer technology among microbes.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the fundamental concepts and characteristic nature of the microbes.
- Perceive knowledge about microbial genetics, culture, and its applications.
- Aware about the beneficial microbes for the safeguarding of the environment.
- Analyze the importance of microbes in product commercialization.
- Comprehend microbial disease management, symptoms, diagnosis, and treatments.

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Second Year **CORE CHOICE COURSE III** **Semester III**

2. REPRODUCTIVE BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To acquire basic knowledge of reproductive physiology.
- To enrich the basic biological concepts of reproductive anatomy, physiology, and endocrinology.
- To attain knowledge about sexually transmitted diseases.
- To highlight cellular and molecular mechanisms controlling reproduction.
- To signify the principles, ethics, and regulatory guidelines involved in Assisted Reproductive Technology.

UNIT – I Introduction to Reproductive Biology:

Gametogenesis - conversion of germ cells – male and female gametes – ovulation - fertilization - implantation - bilaminar germ disc - trilaminar germ disc. Development of male reproductive system - development of female reproductive system - reproductive toxicology and reproductive pathology.

UNIT – II Reproductive Anatomy and Physiology:

Reproductive system - gross anatomy, neuro-endovascular supply. Hormones - gonadotropins - prolactin - melatonin – estrogen – progesterone – testosterone - Triiodothyronine (T3) – Thyroxine (T4) - thyroid stimulating hormone (TSH) - cortisol - dehydroepiandrosterone (DHEA). Mechanism of action of hormone and receptor concerned with reproduction - metabolic control of reproduction. Physiology of pregnancy - parturition and lactation.

UNIT – III Reproductive Immunology:

Basics of immune system - immuno-physiology of male and female reproduction - Immunology of pregnancy - pubertal changes - reproductive ageing – menopause–andropause. Epigenetics of reproduction- prevention of sexually transmitted diseases and reproductive health. Autoimmune disorders.

UNIT – IV Reproductive Disorders:

Developmental abnormalities - menstrual disorders - precocious - delayed or absent puberty - amenorrhea - fertility disorders - sexual dysfunction - infertility -spontaneous pregnancy loss. Pregnancy disorders -pre-eclampsia - Intrauterine growth restriction (IUGR), labor abnormalities. Endocrine disorders - hyperprolactinemia. Genetic disorders (mutations and syndromes) - cancers and biomarkers - testicular - prostate - ovarian - endometrial - cervical and breast.

UNIT – V Assisted Reproductive Techniques (ART), Ethics, Regulatory Laws and Guidelines:

Introduction - semen analysis - ovulation induction - oocyte retrieval. *In vitro* maturation -*in vitro* fertilization (IVF) - Intracytoplasmic sperm injection (ICSI) - Gamete intrafallopian transfer (GIFT). Cryopreservation of gametes and embryos. Embryo biopsy - embryo hatching - pre-implantation genetic diagnosis (PGD) - stem cells and therapeutic cloning. Ethical practices - national and international guidelines for ART - laws regulating gamete donors and surrogacy.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Overview of AI (Artificial Intelligence) and ML (Machine Learning) in Assisted Reproductive Technologies. Overview of mathematical modelling for ovarian simulation.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Describe the anatomy of gametes and relate them to its function.
- Demonstrate the key principles of reproductive endocrinology including hormones and their mechanisms of action.
- Evaluate the principles, merits, and limitations of various types of reproductive technology in use.
- Understand the knowledge of the key steps in sexual determination and differentiation of hormonal levels.
- Explore more on the current scenario in ART for the welfare of mankind.

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Second Year **CORE PRACTICAL III** **Semester III**

COMPARATIVE ANIMAL PHYSIOLOGY AND BIOCHEMISTRY

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

- To provide knowledge on physiology using animal models.
- To make them identify the endocrine glands and highlight their secretions.
- To impart knowledge on osmoregulation in aquatic animals using experiments.
- To skill them with hands-on practice in the estimation of nitrogenous wastes.
- To imply theoretical ideas to understand the structure of endocrine glands and reproductive organs using histological sections.

COMPARATIVE ANIMAL PHYSIOLOGY

Experiments

1. Estimation of RQ in fish with reference to light and temperature.
2. Estimation of salivary amylase activity with reference to temperature and pH.
3. Estimation of salt loss and salt gain in fish.
4. Estimation of O_2 consumption in fish.
5. Blood analysis: Total WBC count, Packed Cell Volume (PCV) and Mean Corpuscular Volume (MCV).
6. Blood analysis: Differential counts.
7. Blood analysis: Total RBC count.
8. Blood grouping by coagulation and Rh factor determination.
9. Estimation of Haemoglobin in human blood.
10. Estimation of blood glucose level in human (GOD kit).
11. Test for urea and sugar in urine sample.
12. Estimation of ammonia, uric acid and urea from samples.

Spotters

Slides: T.S of pineal gland, Thyroid, Parathyroid, Thymus, Adrenal and Pancreas, T.S of Ovary, T.S of Testes, Muscles - (striated, non-striated and cardiac), Nerve cell.

Models: Structure of mammalian eye, organ of Corti.

Instruments: Haemocytometer, Phase contrast microscope, Epi-fluorescent microscope.

BIOCHEMISTRY

Experiments

1. Qualitative analysis of carbohydrates by Fehling's test.
2. Determination of protein by Lowry's method.
3. Estimation of total phenolic compounds by Folin-Ciocalteau method.
4. Estimation of total flavonoid compounds by chromogen reagent method.
5. Determination of amylase.
6. Qualitative test for lipids.

7. Separation of bioactive compounds by paper chromatography.
8. Separation of bioactive compounds by Thin Layer Chromatography (TLC).

Spotters

Bomb calorimeter, Urinometer, High-Pressure Liquid Chromatography (HPLC), Centrifuge, Electrocardiogram (ECG), Glucometer.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Enrich their practical knowledge of various sample biochemical analyses.
- Understand the physiology of circulation, respiration, excretion, and muscle structure from a laboratory.
- Relate the adaptations, mechanism of homeostasis, and osmoregulation in aquatic vertebrates.
- Identify the components of blood that are capable of fine smearing.
- Determine the amount of carbohydrates, proteins, and lipids in any biological samples.

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Second Year **ELECTIVE COURSE III** **Semester III**

1. COMPUTATIONAL BIOLOGY
BIOINFORMATICS AND BIOSTATISTICS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To enrich the basic resources of databases in bioinformatics.
- To practice techniques and tools used in the sequence alignment.
- To relate the concept of conservation analysis and evolutionary relationships using examples.
- To provide knowledge on different computational programs available to predict genes in both Prokaryotes and Eukaryotes.
- To introduce the basic concepts and scopes of biostatistical computing.

UNIT – I Introduction to Biomolecules:

Introduction to biomolecules – DNA – RNA. Genes - genome sequencing method - chemical and enzymatic - whole genome and short gun sequencing. Human Genome Project (HGP) – introduction to biological databases - Nucleic acid sequence data bases - National Center for Biotechnology Information (NCBI) - European Molecular Biology Laboratory (EMBL) - DNA Data Bank of Japan (DDBJ). Protein sequence databases - Protein Information Resource (PIR) - Swiss-Prot and TrEMBL. Structure databases - Protein Data Bank (PDB) - Molecular Modeling Database (MMDB) - Macromolecular structure relational database (MSD). Organism specific databases - Online Mendelian Inheritance in Man (OMIM) - Fly base - EcoCyc - Arabidopsis. Metabolic pathway databases - Kyoto Encyclopedia of Genes and Genomes (KEGG). Open access bibliographic resources and literature databases - PubMed - PubMed Central (PMC) and BioMed Central (BMC).

UNIT – II Sequence Alignment:

Introduction – concept of sequence alignment – local - global - end free space and gap penalties. Scoring matrices - Percent Accepted Mutations (PAM) and BLOcks SUbstitution Matrix (BLOSUM) - methods of pair wise sequence alignment – dot matrix - dynamic and heuristic approaches - algorithms in global and local alignment. Database searching tools – Basic Local Alignment Search Tool (BLAST) and FASTA.

UNIT – III Multiple Sequence Alignment (MSA):

Introduction - methods – sum of pair - progressive and iterative - applications of MSA – software used in MSA - CLUSTALW and TCOFEE. Molecular phylogeny – introduction - distance and character-based methods – automated software for phylogenetic analysis – Molecular Evolutionary Genetics Analysis (MEGA) - Phylogeny Inference Package (PHYLIP) – applications of phylogenetic analysis.

UNIT – IV Computational Gene Analysis:

Introduction to gene prediction – categories of gene prediction programs – gene prediction in Prokaryotes - conventional determination of open reading frames - gene prediction - Markov models - hidden Markov models - performance evaluation. Gene prediction in eukaryotes - gene prediction programs - Ab Initio–based programs - prediction using neural networks - prediction using discriminant analysis - homology-based programs - consensus-based programs - performance evaluation.

UNIT – V Biostatistics:

Statistical packages (SPSS) - spread sheet - creating variables - defining data - data entry - exploring data – graphs and diagrams (finding out layers, conversion of data and transformation data). Steps involved in data analysis for simple descriptive statistics – testing the difference by using nonparametric tests - analysis of variance (ANOVA) - Post-hoc test - partial correlation and multiple regression - principal component analysis.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Fast and accurate multiple sequence alignment (FAMSA) - Functional annotation of genes - Neural network model-R-statistics - online data-statistical analysis - Zero-Inflated Poisson (ZIP) regression.

REFERENCES:

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16. https://blast.ncbi.nlm.nih.gov/Blast.cgi (Blast analysis)
17. https://gtbinf.wordpress.com/biol-41506150/pairwise-sequence-alignment/ (Pairwise data analysis)
18. https://www.ibm.com/docs/en/spss-modeler/18.0.0?topic=networks-neural-model (neural network modeler)
19. https://www.r-project.org/ (R-statistics)
20. https://datatab.net/ (online data analysis)
21. https://www.nature.com/articles/s41598-022-15826-y
22. https://www.nature.com/articles/srep33964
23. https://www.hindawi.com/journals/jps/2018/2834183/

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Retrieve molecular information from a variety of databases.
- Understand the theory behind the sequential analysis and apply the bioinformatics tools used in the sequence alignment.
- Apply, interpret and evaluate the evolutionary relationship among species and molecular taxonomical studies using bioinformatics software.
- Perceive the significance of different gene prediction programs.
- Analyze and interpret the results by statistical analysis of biological data effectively.

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Second Year **ELECTIVE COURSE III** **Semester III**

2. SERICULTURE

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To make them understand the history and socio-economical aspects of sericulture.
- To highlight the classification and morphology of silkworms.
- To enrich theoretical and practical knowledge about the description of mulberry cultivation and pest management.
- To make them learn and understand disease management in sericulture.
- To provide various methodologies followed for the reeling and rearing of sericulture.

UNIT – I History and Overview of Sericulture:

Origin and history of sericulture - environmental impacts - temperate and tropical climate for sericulture practice. Advantages and characteristics of sericulture. Current status of sericulture in India - income and employment generation - role of women in sericulture. National Sericulture Project (NSP) – overview - future scope of sericulture. Role of state - Department of Sericulture (Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal) - role of research organizations and NGOs in sericulture development.

UNIT – II Moriculture and Disease Management:

Biology of mulberry - description and mulberry cultivation in India – selection and preparation of land - cultivation of mulberry – mulberry varieties - different methods of plantation – organic and inorganic manure application- mulberry crop protection. Disease of mulberry leaf - leaf spot - leaf rust - leaf blight, mulberry root - rot and root knot disease. Mulberry pest management - (Mealy bug – *Maconellicoccus hirsutus*), (hairy caterpillar - *Spilosoma obliqua*), (Stem griddler - *Sthenias grisator*), (Jassid - *Amrasca biguttula*) - preventive and control measures.

UNIT- III Taxonomy and Anatomy of Silkworm:

Silkworm taxonomy - classification of silkworms based on number of larval moults - (moultinism) and generations produced (voltinism) – Vanya - Tasar - Muga - Eri. Morphology and life cycle of silk worm (*Bombyx mori*) - Organization of larvae - pupae and moth. Structure of the silk gland and importance. Silkworm anatomy - digestive system of larva. Circulatory system - larva - pupa and adult.

UNIT – IV Farming Practices:

Silkworm rearing house - disinfection of rearing houses and appliances used for rearing - feeding – moulting - egg production. Silk worm pests - uzi fly - ants and demisted beetles. Diseases of silk worm - Bacterial (Flacherie) - Fungal (Muscardine) - Protozoan (Pebrine) and Viral (Grasserie) diseases and its preventive measures.

UNIT – V Post Cocoon Technologies:

Introduction - cocoon stifling (sun drying, steam stifling, hot air stifling) - storage of cocoon - sorting of cocoons. Concept of difference reeling machines - reeling operation - reeling end formation. Harvesting of cocoon (stifling, storage and sorting). Reeling methods – reeling and re-reeling. Silk examination - cleaning - lacing - bookmarking and grading of silk.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

rDNA technology for silkworm crop improvement and regulated gene expression - marker assisted breeding both silkworm and mulberry - strength weakness opportunity and threat (SWOT) techniques - environmental hazards in sericulture - pollutants and their effects in sericulture and moriculture.

REFERENCES:

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the economic and ecological impacts and income generation by sericulture as an agro-based industry.
- Enrich the knowledge about the basic biology of silkworm production.
- Expertise in taxonomy, morphology, and identifying life cycle stages of the silkworm.
- Relate the strategies involved in the sericulture management system.
- Acquire knowledge about the technologies and the role of government and non-governmental sectors in sericulture.

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Second Year **NON MAJOR ELECTIVE II** **Semester III**

POULTRY FARMING

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- To provide information about poultry and its importance.
- To give an idea of self-employment opportunities to the students.
- To make them understand the role of different research organizations and funding agencies promoting poultry farming.
- To know about the economic importance of poultry and its products.
- To study the management strategies of poultry farming.

UNIT – I Poultry Production:

Introduction - poultry production in India - economic importance of poultry production – common breeds of poultry - American class - English class - Asiatic class and Indian class. Important characters of modern breeds of poultry. Economic traits of meat – nomenclature of breeds of fowl - classification of fowls - selection of breeds. Housing and equipment – general principles of building poultry sheds - deep litter system - laying cages.

UNIT – II Brooding and Rearing:

Natural and artificial brooding – methods of brooding - brood temperature - space and duration - feed - water -space allowance – vaccination. Management of growers - layers - broilers – summer and winter management - debeaking and culling. Poultry manure – volume - composition - value and disposal.

UNIT – III Feed Composition and Nutrients:

Feeds for grower and layers - feed additives – usage of food additive – impact on human health. Food stuffs for poultry in relation to protein - amino acids - minerals (Ca and P) - vitamins and fibre content. Feed formulations for chicks - growers - layers and broilers. Nutritive value of egg - factors affecting egg size - storage and preservation of egg - marketing - incubation and hatching of eggs. Annual egg production in India.

UNIT – IV Prevention and Control of Diseases:

Introduction - common bacterial - viral - fungal - protozoan and nematodes diseases – symptoms- prevention - control and treatment. Arthropod pests - ticks - mites and lice affecting poultry and their control measures.

UNIT – V Poultry Marketing:

Introduction - processing -preservation - grading - storage and marketing of eggs and meat. Economics of poultry production – problems in poultry production units to examine first hand rearing and business operation status.

UNIT-VI: CURRENT CONTOURS (For continuous internal assessment only):

New traits of malfunctioning genes in poultry science - gene editing technology - transgenic feed supplementation to poultry farming animals-poultry farming applied new strategies for copping diseases - Geographic information system (GIS).

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the importance and strategies to be followed in poultry rearing and marketing.
- Perceive the methods involved for brooding and its management.
- Enrich knowledge about feed formulation and requirements for poultry farming.
- Comprehend disease management strategies implemented during poultry farming.
- Create awareness about skill development for the welfare of the people.

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Second Year	**CORE COURSE VII IMMUNOLOGY**	**Semester IV**
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

- To impart knowledge about organs and their role as immune systems.
- To study and compare the cells of immunity and their role in the protection of the human body.
- To familiarize the terms antigen, antibody concepts, hypersensitivity, MHC, and complement pathways.
- To perceive immunological techniques used in clinical testing.
- To enrich knowledge about autoimmune diseases using examples.

UNIT – I Organs of Immune System:

History and scope of immunology - innate and acquired immunity. Lymphoid system -primary and secondary lymphoid organs - tissues. Cells of immune system - lymphoid lineage - myeloid lineage. Molecules- complement - acute phase proteins - interferons - lymphokines and cytokines and phagocytosis.

UNIT – II Antigens and Antibody:

Antigens - types of antigens – factors affecting antigenicity. T cell and B cell epitopes -haptens - adjuvants and carriers. Antibodies - Molecular structure of immunoglobulin – types. Immune response - humoral -cell mediated immune response. Superantigens - antigen-antibody interactions *in vitro* and *in vivo* studies.

UNIT – III Hypersensitivity and Transplantation:

Hypersensitivity - definition and classification - Types (I, II, III, IV and V). Major Histocompatibility Complex (MHC) in mouse - HLA system in human - cellular distribution - peptide binding. Complements - Complement activation - classical - alternate pathway. Mannose-binding Lectin & Lytic Pathway - Transplantation immunology - types of grafts- allograft rejection - prevention of allograft rejection - Tissue Typing.

UNIT – IV Vaccination and Autoimmunity:

Introduction – vaccine - principle and types - antigen as vaccines - subunit vaccines - recombinant vaccines - anti-idiotypic antibodies. Vaccination schedule for humans. Tumour immunology - tumour antigens- immune response to tumours - immunotherapy - tumour vaccines. Autoimmune diseases. Immunodeficiency - inherited and acquired.

UNIT – V Immuno-techniques:

Clinical methods for detection of antigens and antibodies – immunodiffusion - immuno-electrophoresis. Binder-ligand assays – Radio Immuno Assay (RIA), Enzyme-Linked Immuno-Sorbent Assay (ELISA) - Enzyme Multiplied Immunoassay Technique (EMIT). Western and Southern blotting - Chemiluminous Immuno Assay (CLIA). Histocompatibility testing - HLA typing - Restriction Fragment Length Polymorphism (RFLP) - Polymerase Chain Reaction (PCR). Autoimmune disease detection - rheumatoid arthritis - hepatitis–B virus test. Immune complex detection.

UNIT –VI CURRENT CONTOURS (For continuous internal assessment only):

Recent research works on increasing immunity in mucosal sites – antibody - Fluorophor conjugate-super antigen-like pathogen-Single Nucleotide Polymorphisms (SNPs)-hematopoietic stem cell transplantation - strategies followed in the kidney transplantation.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the difference between natural and acquired immunity.
- Classify the role of immunoglobulins and understand vaccine production.
- Realize the various mechanisms that regulate immune responses.
- Understand the structure and function of antibodies and immunological techniques.
- Comprehend the adverse effect of the immune system causing autoimmune disorder.

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Second Year **CORE COURSE VIII** **Semester IV**

EVOLUTION

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To provide an idea of the origin and evolution of life through shreds of evidence.
- To make them relate and understand theories of evolution.
- To provide a thorough knowledge of molecular processes of evolution.
- To highlight population growth and speciation.
- To justify the importance of molecular evolution using techniques.

UNIT – I Evidences of Evolution:

Origin of life – biochemical origin of life – Urey–Miller experiment. Evidences of evolution – morphology and anatomy - embryology - physiology - genetic - biochemical and paleontology.

UNIT – II Theories of Organic Evolution:

Lamarckism - neo-Lamarckism - Darwinism - neo- Darwinism. Mutation theory - modern synthetic theory. Natural selection - convergent - divergent and parallel evolution.

UNIT – III Evolutionary Process:

Genetic basis for variation – mutation - isolating mechanism – speciation – adaptation – colouration and mimicry – neoteny – genetic drift – Hardy Weinberg Equilibrium.

UNIT – IV Species Selection and Population Growth:

Species selection – population genetics – metapopulations. Monitoring natural populations – extinction of small populations – loss of genetic variations. Conservation of genetic resources in diverse taxa – artificial evolution. Origin of higher taxa – evolution of *Homo sapiens*.

UNIT – V Molecular Phylogeny and Evolution:

History of molecular phylogenetics - evolution of amino acid sequences. DNA sequences – nucleic acid phylogeny, DNA – DNA hybridization – nucleotide sequences – nucleic acid and amino acid phylogenies. Molecular clock – regulatory genes and evolution. Gene evolution – evolution of gene families – molecular drive-assessment of molecular variation.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Unnatural selection - uncovering the mysterious origin of human sacrifice - evolution of the plague strain – hidden ancient and recent research in human evolution.

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the process and evidence of evolution.
- Gain knowledge of the theories regarding evolution.
- Get deep knowledge of types of the evolutionary process.
- Comprehend the population genetics and conservation.
- Get an in-depth understanding of molecular evolution.

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Second Year	**ENTREPRENEURSHIP / INDUSTRY BASED COURSE VERMITECHNOLOGY**	**Semester IV**
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

- To create awareness about vermiculture and technology.
- To emphasize the designing of the vermitech unit and its resources.
- To know and highlight the mechanism of waste degradation using earthworms and managing solid wastes.
- To relate the theoretical concepts of earthworms and their microbial interactions in soil fertility.
- To provide imbibe knowledge on application-oriented skills of vermitechnology.

UNIT – I Introduction to Vermiculture:

Vermiculture – importance - general species for culture. Collection and preservation of earthworms - role of ecological importance -significance. Pest control and disease management. Recent developments in vermiculture around the world and in India.

UNIT – II Vermitechnology:

Vermitechnology - definition - scope - history - growth and developments. Construction of compost beds - management techniques - systems of vermicomposting. Vermicompost methods (small and large scale) - field pits - ground heaps - tank method - roof shed method - static pile windrows - top fed windrows - wedges and bin method. Factors affecting vermicomposting - parameters (pH, moisture, humidity and temperature). Worm casts and vermiwash - collection - production techniques - role of earthworms in soil fertility - nutritional composition of vermicompost for crop productivity.

UNIT – III Waste Recycling Management:

Earthworms in waste management - farmer's friend -disposal of solid waste an option for source revitalization - competent hotel waste management system. Vermicompost applications in a nursery – vermifilter - earthworms as bioreactor. Organic farming - advantages in earthworm activity over chemical fertilizers. Vermiculture for waste reduction - economic importance of earthworms.

UNIT – IV Earthworms and Microorganisms:

Earthworm classification - morphology and anatomy - diversity - indigenous and exotic species of earthworm - Anecic earthworms (*Aporrectodea longa*, *Aporrectodea nocturna* and *Lumbricus friend*). Endogeic earthworms (*Allolobophora chlorotica*, *Apporectodea caliginosa* and *Apporectodea icterica*). Epigeic earthworms (*Dendrobaena octaedra*, *Eiseniella tetraedra* and *Lumbricus festivus*). Compost earthworms (*Eisenia fetida* and *Dendrobaena veneta*).

Interactions of earthworms with other organisms - microorganisms - microorganisms associated in earthworm guts - different types of soil microbes - Actinomycetes - Fungi - Protozoans - Nematodes.

UNIT – V Advantages and Applications of Vermitechnology:

Introduction - vermicompost applications on soil and crop productivity - organic fertilizer. Economics of vermicomposting products - innovative waste management technologies for sustainable development - domestic wastewater management. Formulation of feed and fertilizer - financial support from government and NGOs for vermiculture.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Genome and single cell RNA sequencing of the earthworm - earthworm toxico-genomics. Next generation sequencing - metagenomic analysis - integrated vermiculture and aquaculture farming.

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2. Ismail, S.A. (2005). The Earthworm Book. II Revised Edition, Other India Press, Goa, India.
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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Acquire knowledge about the scope of vermitechnology.
- Differentiate the environmental factors affecting the vermicompost unit.
- Generate income from selling organic manures made from household - solid wastes.
- Be aware of the impact of vermicompost over other fertilizers for a sustainable environment.
- Understand the advantages of vermitechnology and can implement environment-friendly techniques in the future.

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Second Year **PROJECT** **Semester IV**

Code: **(Theory)** **Credit: 5**

The candidate shall be required to take up a Project Work by group or individual and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT/EVALUATION/VIVA VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External)

   I. Plan of the Project - 20 marks

   II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks

   III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Second Year **VALUE ADDED COURSE II NANOBIOTECHNOLOGY** **Semester IV**

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- To make them understand the fundamental concepts of nanotechnology and its unique properties.
- To provide knowledge on the synthesis of various characterization techniques.
- To highlight the importance of fabrication techniques and their biological applications.
- To demonstrate the applications of nanomaterials in various streams.
- To make them learn toxicity mechanisms and regulatory functions of nanomaterials.

UNIT – I Generic Methodologies for Nanobiotechnology:

Introduction to nanotechnology - challenges and opportunities associated with biology on the nanoscale. Top-down approaches – sputtering - chemical etching - thermal/laser ablation - mechanical/ball missling. Bottom-up approaches - vapour deposition - sol-gel process - spray pyrolysis - aerosol process - bioreduction. Advantages and disadvantages of nanotechnology.

UNIT – II Nanomaterials Synthesis and Characterization Techniques:

Synthesis of nanoparticles - characterization techniques - UV-Visible spectrophotometer - Field Emission Scanning-Electron Microscopy (FE-SEM) - Energy Dispersive X-ray (EDX) - High Resolution-Scanning Electron Microscopy (HR-TEM) - Dynamic Light Scattering (DLS) - zeta potential -Fourier Transform - Infra red (FT-IR) - X-ray Diffraction (XRD) and Raman spectroscopy.

UNIT – III Introduction to Sensors:

Principles of biosensors -types - important component of biosensor - materials for biosensor applications. Fabrication of biosensor devices - electrochemical methods - techniques used for microfabrication - biological applications.

UNIT – IV Bionanomaterials:

Biomolecules for designing nano-structures - nanoprinting of DNA - RNA - proteins - biological and medical applications. Classification of nanomaterials - properties and applications of bionanomaterials - tissue engineering - drug delivery - controlled release and disease diagnosis.

UNIT – V Toxicology and Environmental Safety:

Introduction to nanomaterials - toxicological effects - bioaccumulation - biotransformation - cytotoxicity and genotoxicity. Mechanism of nanomaterials toxicity - oxidative stress - ecotoxicity - mutagenicity and immunotoxicity. Ethics and regulations issues in nanotechnology - exploration pattern matters associated with nanotechnology - social impacts and human resources for nanotechnology.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Smartphones to detect early Alzheimer's disease -biosensor technology for the detection of kidney disease – three-dimensional (3D) printing technologies for tissue regeneration therapy.

REFERENCES:

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COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Acquire mastery of synthesis procedures and their chemical interactions.
- Understand the fundamental applications of various analytical instruments.
- Understand the usage of biosensor devices for the early detection of infectious diseases.
- Apply bionanomaterials in biomedical research and therapeutic applications.
- Profile the individual nanomaterial toxicity profile and mechanistic pathways.

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