Sadakathullah Appa College

(Autonomous)

(Reaccredited by NAAC atan'A^{++}' Grade. An ISO 9001:2015 Certified Institution)

RahmathNagar,Tirunelveli-11.

TamilNadu.

PG DEPARTMENT OF ZOOLOGY

CBCSSYLLABUS

M.Sc.ZOOLOGY

(Applicable for students admitted in June 2024 and onwards)
(As per the Resolution of the Academic Council Meetings held on 01.06.2024)

CONTENTS

PG DEPARTMENT OF ZOOLOGY
Programme Structure & Credits 2024 – 2027

Sem	Course Type	Title of the Course	Course Code	H/W	C	Marks		
						I	E	T
I	Core-I	Structure and Function of Invertebrates	24PCZO11	6	5	40	60	100
	Core-II	Comparative Anatomy of Vertebrates	24PCZO12	5	5	40	60	100
	Core-III	Cellular and Molecular Biology	24PCZO13	5	4	40	60	100
	Core-P-I	Lab Course in Invertebrates & Vertebrates	24PCZO1P1	4	2	20	30	50
	Core-P-II	Lab Course in Cell and Molecular Biology	24PCZO1P2	4	2	20	30	50
	EC-I	Molecules and their interaction relevant to Biology	24PEZO11A	4	3	40	60	100
		Medical Laboratory Techniques	24PEZO11B					
		Animal Feed Technology	24PEZO11C					
	EC-II (IDC-I)	Poultry Farming	24PIZO11	2	2	15	35	50
		SOP		-	-			
				30	**23**			**550**
II	Core-IV	Developmental Biology	24PCZO21	5	5	40	60	100
	Core-V	Biostatistics	24PCZO22	5	4	40	60	100
	Core-P-III	Lab Course in Developmental Biology	24PCZO2P1	4	2	20	30	50
	Core-P-IV	Lab Course in Biostatistics and Research Methodology	24PCZO2P2	4	2	20	30	50
	EC-III	Apiculture	24PEZO21A	4	3	40	60	100
		Vermiculture	24PEZO21B					
		Microbiology	24PEZO21C					
	EC-IV (IDC-II)	Bio-Composting	24PIZO21	2	2	15	35	50
	SEC-I	Research Methodology	24PSZO21	4	3	40	60	100
	SEC-II	Skill Enhancement Course-III NPTEL-SWAYAM Online Certification Course (or) NaanMuthalvan: (Choose any one course from the list of courses suggested by TANSCHE)	24PSZO22	2	2	-	-	50
		SOP		-	1			100
	Summer – Internship Industry Training during the 1st year vacation - credits be given in the third semester mark statement							
				30	**23+1**			**700**

EC – Elective CourseSEC – Skill Enhancement Course

Generic - Unrelated discipline

M.Sc. Zoology

Programme Outcomes

PO	Upon completion of M.Sc. Degree Programmes, the graduates will be able to:
PO 1	**Disciplinary Knowledge** • Acquire in-depth scientific knowledge in the core areas of study.
PO 2	**Creative Thinking and Practical Skills / Problem Solving Skills** • Enrich skills of observation to draw logical inferences from scientific experiments /programming and skills of creative thinking to develop novel ideas. • Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations.
PO 3	**Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship** • Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. • Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects. • Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PO 4	**Ethical Awareness / Team Work / Environmental Conservation and Sustainability** • Equip them for conducting work as an individual / as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviours such as fabrication, falsification, misrepresentation of data, plagiarism etc. to ensure academic integrity. • Realise that environment and humans are dependent on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PO 5	**Digital Literacy/Self-Directed Learning/Usage of ICT/Lifelong Learning** • Get access to digital resources, to use them judiciously for updation of knowledge and also to engage in remote/ independent learning. • Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes

PSO	Upon completion of Postgraduate Degree in Zoology, the graduates will be able to:
PSO 1	**Advanced Knowledge and Understanding** • Acquire in-depth knowledge of various zoological concepts, including animal physiology, biochemistry, Molecular biology, genetics, taxonomy, evolution, biotechnology, biostatistics, bioinformatics, Embryology and ecology etc. • Understand the complexity and diversity of animal life and the evolutionary processes that shape it.
PSO 2	**Practical Skills and Technical Competence** • Attain practical proficiency in various laboratory techniques, including microscopy, separation and isolation instruments and molecular biology tools etc. • Develop competency in handling animals and conducting field studies with ethical considerations. • Integrate modern technology and computational tools in zoological research and data analysis.
PSO 3	**Critical Thinking, Problem-Solving and Research Proficiency** • Develop advanced research skills including hypothesis formulation, experimental design, data collection, and statistical analysis. • Enhance critical thinking abilities to analyse and interpret scientific data and literature. • Apply problem-solving skills to address biological questions and ecological issues.
PSO 4	**Environmental Conservation Awareness and Social Impact** • Understand the principles of wildlife conservation and management. • Recognize the importance of biodiversity and the impact of human activities on ecosystems. • Understand the role of zoologists in addressing societal challenges such as public health, climate change, and sustainable development.
PSO 5	**Professional and Ethical Responsibilities and Lifelong Learning** • Develop a sense of professional ethics and responsibility in the conduct of research and the application of zoological knowledge. • Cultivate an attitude of lifelong learning to stay updated with the latest developments in zoology and related fields. • Prepare for advanced careers in academia, research institutions, environmental agencies, and industries related to zoology and wildlife.

Semester - I	Structure and Function of Invertebrates		24PCZO11			
Core – I			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	5	1	-	5

General Objective:

To provide students with comprehensive understanding of the diversity, anatomy, physiology, ecological roles, and behavioural adaptations of invertebrates.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the diversity and classification of invertebrate species within the animal kingdom.
LO-2	Comprehend fundamental physiological processes, including digestion, respiration, circulation, excretion, and reproduction in invertebrates
LO-3	Explore behavioral adaptations and the neural and sensory systems of invertebrates.
LO-4	Develop practical skills in observing, identifying, and classifying invertebrates using laboratory and field techniques.
LO-5	Understand conservation issues and applied aspects of invertebrate biology in various fields.

UNIT I -Taxonomy

Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; new trends in taxonomy.

UNIT II –Organization

Organization of coelom: Acoelomates; Pseudo coelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata.

UNIT III – Digestion and Respiration

Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration

UNIT IV – Excretion and Nervous System

Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and lnsecta) and Mollusca (Cephalopoda); Trends in neural evolution

UNIT V – Larval Stages

Invertebrate larvae: Larval forms of free living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters

Textbooks:

1. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.

Reference Books:

1. Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024.
2. Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi.
3. Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.
4. Modern text book of Zoology – Invertebrates (Animal Diversity-I)by R.L. Kotpal (X Edn.)

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	1,3,4,5	K1 & K2
CO-2	Understand the evolutionary process. All are linked in a sequence of life patterns.	1,3,4,5	K2 & K4
CO-3	Apply this for pre-professional work in agriculture and conservation of life forms.	1,2,3,4,5	K3 & K5
CO-4	Analyze what lies beyond our present knowledge of life process.	1,3,4,5	K4 & K6
CO-5	Evaluate and to create the perfect phylogenetic relationship in classification.	1,2,3,4,5	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCZO12	Structure and Function of Invertebrates	90	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	2	3	3	3	3	2	3	3	3
CO-2	3	2	3	2	3	3	2	3	2	3
CO-3	3	3	2	3	3	3	3	3	3	3
CO-4	2	3	2	3	2	3	2	3	3	3
CO-5	3	2	3	2	3	3	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Comparative Anatomy of Vertebrates		24PCZO12			
Core – II			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	5

General Objective:

To understand the similarities and differences in the anatomical structures of vertebrates and to explore how these structures have evolved and adapted to different environments.

Learning Objectives

LO	The learners will be able to:
LO-1	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.
LO-2	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.
LO-3	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals
LO-4	Imparting conceptual knowledge about the animal life in the air and their behaviours.
LO-5	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.

UNIT I -Origin, Scope and Importance of Vertebrates

Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; Definition, scope and relation too the disciplines; Importance of the study of vertebrate morphology.

UNIT II –Classification and General Structure of Vertebrates

Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers andhairs.

UNIT III – Circulation and Respiration

General plan of circulation in various groups; Blood; Evolution ofheart; Evolution of aortic arches and portal systems. Respiratory system:

Characters of respiratory tissue; Internal and external respiration; Comparative account of respiratory organs

UNIT IV – Skeletal and Urogential system

Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrateseries.

UNIT V – Sense Organs and Nervous system

Senseorgans: Simple receptors; Organs of Ol faction and taste; Lateral line system; Electro reception. Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinalcord; Nerves-Cranial, Peripheral and Autonomous nervoussystems.

Reading list:

1. Swayam Prabha: https://www.swayamprabha.gov.in/index.php/ program/archive/9
2. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.
3. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.

Reference Books:

1. Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.
2. Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.
3. Ekambaranatha Ayyar and T. N. Ananthakrishnan. 2009. Manual of Zoology, Vol – II, S. ViswanathanPvt. Ltd. Chennai.
4. Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all vertebrates.	1,3,4,5	K1 & K2
CO-2	Understand the evolutionary process. All are linked in a sequence of life patterns.	1,3,4,5	K2 & K4
CO-3	Apply conceptual knowledge in classification and perform comparative analysis of various organ system in vertebrates	1,2,4,5	K3 & K5
CO-4	Analyze the role of different organs and their functions	1,3,4,5	K4 & K6
CO-5	Evaluate and to create the perfect phylogenetic relationship in classification.	1,2,3,5	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCZO12	Comparative Anatomy of Vertebrates	75	5

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	2	3	2	2	3
CO-2	2	3	3	3	3	2	3	3	3	3
CO-3	2	3	3	3	3	3	3	3	2	2
CO-4	3	2	2	2	3	2	2	3	3	3
CO-5	3	3	3	3	3	2	2	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Signature: Head of the Department

Semester - I	Cellular and Molecular Biology		24PCZO13			
Core – III			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	3	1	-	4

General Objective:

To provide students with a thorough understanding of the structure and function of cells, the molecular mechanisms that govern cellular processes, and the techniques used to study cells and their components.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the ultra-structure and functions of basic components of prokaryotic and eukaryotic cells.
LO-2	Realize involvement of various cellular components in accomplishing cell division.
LO-3	Understand the nature and importance of cell communications
LO-4	Understand the Characteristic features of normal and cancer cells
LO-5	Enable a successful performance in cell biology component of CSIR-UGC NET

UNIT I - Cellular Organization

General features of the cell: Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutroplasm - cell organelles; cell theory; Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, active transport, ion pumps, mechanism and regulation of intracellular transport.

UNIT II –Structure and functions of Cell Organelles

Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum and Ribosomes.

UNIT III – Cell Division and Molecular Biology

Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro and eukaryotic cells.

UNIT IV – Cell Communication

Cell communication and cell signaling: Membrane- associated receptors for peptide and steroid hormones - signaling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures.

UNIT V – Cancer and Apoptosis

Cancer cells: Characteristic features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, significance of apoptosis; Molecular designing of cancer treatment

Textbooks:

1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765.
2. Lodish, H., C. A. Kaiser, A. Bretscher, *et al.*, 2013. Molecular Cell Biology (Seventh Edition), Macmillan, England, pp-1154
3. De Robertis, E.D.P. and E. M. F. De RobertisJr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734
4. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007, Cell and Molecular Immunology (Sixth Edition), Saunders, Philadelphia, pp-566
5. Loewy, A.G., P. Siekevitz and J. R. Menninger, *et al.*, 1991, Cell Structure and Function(Third Edition), Saunders, Philadelphia, pp-947

Reference Books:

1. Plopper, G., D. Sharp, and E. Sikorski. 2015. Lewin's Cells (Third Edition), Jones & Bartlett, New Delhi, pp-1056
2. Plopper, G. 2013. Principles of Cell Biology, Jones & Bartlett, Maryland, pp-510

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the general concepts of cell and molecular biology.	1,2,4,5	K2
CO-2	Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and cellular structures influencing functional features.	1,2,3,5	K1 & K2
CO-3	Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response.	1,2,3,4	K3 & K4
CO-4	Updated the knowledge on the rapid advances in cell and molecular biology and various diseases.	1,3,4,5	K5
CO-5	Understand the factors associated with the detail of cancer cell cycle and treatment of cancer	1,2,3,5	K2

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCZO13	Cellular and Molecular Biology	75	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	3	3	3	3	3	3	3	3	2
CO-2	3	3	3	3	3	3	2	3	2	3
CO-3	3	3	3	3	2	3	2	3	2	3
CO-4	3	2	2	3	2	2	2	3	3	3
CO-5	3	3	3	2	2	3	3	2	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Lab Course in Invertebrates & Vertebrates		24PCZO1P1			
Core – P-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	1	-	3	2

General Objective:

To develop hands-on skills in observing, identifying, dissecting, and analyzing the anatomical and physiological characteristics of various invertebrate and vertebrate species.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the different systems in invertebrates &vertebrates.
LO-2	Learn about various animal species, their phylogenetic affinities and their adaptive features
LO-3	Impart conceptual knowledge about the salient features and functional anatomy.
LO-4	Develop the skill in mounting techniques of the biological samples.
LO-5	Gain fundamental knowledge on the skeletal system

INVERTEBRATES

Dissection

Earthworm : Nervous system
Pila : Digestive and nervous systems (Virtual Dissection)
Cockroach : Nervous system
Grasshopper : Digestive system
Prawn : Appendages, nervous and digestive systems

Study of the following slides with special reference to their salient features and their modes of life

1. *Amoeba*
2. *Entamoebahistolytica*
3. *Paramoecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria*larva
7. *Tape worm (Scolex)*
8. *Ascaris*T. S.
9. Mysis of prawn

Spotters

1. Scorpion
2. *Penaeusindicus*
3. *Emerita* (*Hippa*)
4. *Pernaviridis*

Mounting

Earthworm :Bodysetae

Pila :Radula (Virtual Dissection)

Cockroach :Mouth parts

Grasshopper: Mouth parts

CHORDATES

Study the nervous system of Indian dog shark – Virtual Dissection

1. Nervous system of *Scoliodonlaticaudatus* – 5thor Trigeminal nerve
2. Nervous system of *Scoliodonlaticaudatus* – 7thor Facial nerve
3. Nervous system of *Scoliodonlaticaudatus* – 9th and 10th or Glossopharyngeal &Vagus nerve

Study of the following specimens with special reference to their salient features and their modes of life

1. *Amphioxus* sp. (Lancelet)
2. *Ascidia* sp. (sea squirt)
3. *Scoliodonlaticaudatus*(Indian dog shark)
4. *Torpedo* sp. (Electric ray)
5. *Arius maculatus*(Cat fish)
6. *Belonecancila*(Flute fish)
7. *Mugilcephalus*(Mullet)
8. *Oreochromismossambicus*(Tilapia)
9. *Tetrodonpunctatus*(Puffer fish)
10. *Dendrophis*sp. (Tree snake)

Study of the different types of scales in fishes

1. Cycloid scale
2. Ctenoid scale
3. Placoid scale

Study of the frog skeleton system (Representative samples)

1. Skull
2. Hyoid apparatus
3. Pectoral girdle and sternum
4. Pelvic girdle
5. Fore limb
6. Hind limb

Mounting

1. Weberianossicles of fish

Text Books:

1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.

3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528

Reference Books:

1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjeee, P. Chattopadhya. 2011. Advanced Practical Zoology, ArunabhaSen Publishers, pp-1070.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the structure and functions of various systems in animals	1,3,4,5	K1 & K2
CO-2	Learn the adaptive features of different groups of animals	1,3,4,5	K2 & K4
CO-3	Learn the mounting techniques	1,2,4,5	K3 & K5
CO-4	Acquire strong knowledge on the animal skeletal system	1,3,4,5	K4 & K6
CO-5	Analyze the different types of scales in fishes	1,2,3,5	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCZO1P1	Lab Course in Invertebrates & Vertebrates	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	2	3	3	3
CO-2	3	3	3	3	3	3	2	3	3	3
CO-3	2	2	2	3	3	2	3	2	3	3
CO-4	3	3	3	3	2	3	2	3	3	3
CO-5	3	3	2	2	3	3	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Lab Course in Cell and Molecular Biology		24PCZO1P2			
Core – P-II			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	1	-	3	2

General Objective:

To provide students with hands-on experience in laboratory techniques and methodologies used to study cellular and molecular processes.

Learning Objectives

LO	The learners will be able to:
LO-1	Gain proficiency in fundamental laboratory techniques such as microscopy, centrifugation, and spectrophotometry.
LO-2	Collect, analyze, and interpret experimental data to draw meaningful conclusions about cellular and molecular processes.
LO-3	Perform protein extraction, quantification, and analysis using techniques such as SDS-PAGE
LO-4	Gain knowledge in detection of polytene chromosomes and in detection of sex chromatin
LO-5	Perform blood cells identification in the haemolymphof the cockroach

Experiments

1. Determination of cell size using micrometer
2. Mitosis in root meristematic cells of plants
3. Identification of various stages of meiosis in the testes of grasshopper
4. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomous
5. Detection of sex
6. bacterial cells/tissues
7. Agarose gel electrophoresis chromatin
8. Identification of blood cells in the haemolymph of the of the cockroach
9. Isolation of genomic DNA from eukaryotic tissue
10. Isolation of total RNA from DNA
11. SDS-Polyacrylamide gel electrophoresis

Spotters

1. Structure of mitochondria
2. Golgi bodies
3. Structure of DNA, mRNA, tRNA and rRNA
4. Apoptosis
5. Oncogene

Reference Books:

1. Gerald Karp, "Cell and Molecular Biology: Concepts and Experiments", Wiley India Pvt. Ltd,2013
2. P.S. Verma and V.K. Agarwal, "Cell Biology, Genetics, Molecular Biology, Evolution and Ecology", S. Chand Publishing,2016

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development.	1,3,4,5	K2
CO-2	Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques.	1,3,4,5	K3
CO-3	Examine the Polytene chromosome in salivary gland cells of the larvae of the Chironomous	1,2,4,5	K6
CO-4	Identification of blood cells in the haemolymph of the cockroach	1,3,4,5	K1 & K2
CO-5	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities	1,2,3,5	K1 & K2

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PCZO1P2	Lab Course in Cell and Molecular Biology	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	3	3	3	3	3	2	3	3	3
CO-2	3	2	3	3	2	3	2	3	3	3
CO-3	3	2	2	3	3	3	3	2	3	3
CO-4	3	3	3	2	2	3	2	3	3	3
CO-5	3	2	3	3	3	3	3	3	2	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Molecules and their interaction relevant to Biology		24PEZO11A			
EC–IA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To provide students with a thorough understanding of the chemical principles underlying biological processes.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the structure, properties, and functions of biomolecules such as proteins, nucleic acids, carbohydrates, and lipids.
LO-2	Explore the principles of enzyme kinetics, mechanisms of enzyme action, and factors affecting enzyme activity.
LO-3	Study the major metabolic pathways, including glycolysis, the citric acid cycle, oxidative phosphorylation, and photosynthesis, and understand their regulation and integration.
LO-4	Comprehend the principles of bioenergetics, including the thermodynamics of biochemical reactions and the role of ATP in energy transfer.
LO-5	Learn about the molecular basis of genetic information flow, including DNA replication, transcription, and translation.

UNIT I -Basic Principles of biochemistry

Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

UNIT II –Biomolecular interactions

Biomolecular interactions and their properties:Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. - Composition, structure, metabolism and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

UNIT III – Bioenergetics and enzymology

Bioenergetics and enzymology:Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes.

UNIT IV – Protein Structure

Structural conformation of proteins and nucleic acids:Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds) - Conformation of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA).

UNIT V – Lipids

Lipid - structure, Classification – simple, compound and derived lipids - properties and functions - Biosynthesis of fatty acids and Acylglycerol - phospholipids - metabolism of fatty acids – β oxidations, ketogenesis and Cholesterol.

Textbooks:

1. Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Edition., W.H. Freeman & Co., New York, pp-1050.
2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.
3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.
4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.
5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.

Reference Books:

1. Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280.
2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw-Hill Companies, Inc., USA, pp-704.
3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.
4. Voet D. and J.G. Voet. 2011. Biochemistry. (4thEdition). John Wiley & Sons (Asia) Pvt. Ltd., pp-1428.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Learn the structure, properties, metabolism and bioenergetics of biomolecules	1,2,4,5	K1 & K3
CO-2	Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation	1,3,4,5	K1 & K2
CO-3	Understand the fundamentals of biophysical chemistry, biochemistry and biopolymers.	1,2,3,4	K2 & K3
CO-4	Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids	2,3,4,5	K2 & K4
CO-5	Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures	1,2,4,5	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PEZO11A	Molecules and their interaction relevant to Biology	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	3	3	3	3	2	3	3
CO-2	2	3	3	3	3	3	2	3	3	3
CO-3	3	3	2	2	3	3	3	3	3	2
CO-4	3	2	3	3	3	2	3	3	3	3
CO-5	3	3	3	2	3	3	3	2	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – I	Medical Laboratory Techniques		24PEZO11B			
EC–IB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To equip students with the theoretical knowledge and practical skills necessary to perform a wide range of diagnostic tests and laboratory procedures.

Learning Objectives

LO	The learners will be able to:
LO-1	Familiarize with laboratory safety protocols, ethics, and regulations.
LO-2	Learn proper techniques for collecting, labeling, and transporting patient specimens.
LO-3	Develop proficiency in basic laboratory techniques such as pipetting, dilution, and solution preparation.
LO-4	Perform hematological tests to analyze blood cells, hemoglobin levels, coagulation parameters, and other blood components.
LO-5	Interpret molecular diagnostic results and their clinical implications.

UNIT I - Laboratory Practices

Laboratory safety - toxic chemicals and biohazards waste- biosafety level- good laboratory practice - hygiene and health issue - physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.

UNIT II – Human blood

Composition of blood and their function- collection of blood & lab procedure-haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin- erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing- haemostasis-

bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.

UNIT III – Microbial Pathogens and Diagnostics

Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome- Computer tomography (CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET.

UNIT IV – Cardiogram and Encephalogram

Cardiovascular system- Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography- Electroencephalography (EEG).

UNIT V – Specimen handling and Microtome

Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.

Textbooks:

1. Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi.
2. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia.Published by Tata McGraw-Hill Education Pvt. Ltd.,
3. Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

Reference Books:

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.
2. Guyton and Hall, 2000. Text Book of medical Physiology, 10th edition, Elseiner, New Delhi.
3. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol,I,II,III. Tata MC GrawHill, New Delhi.
4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.	1,2,3,5	K1 & K3
CO-2	Explain the characteristics of clinical samples and demonstrate skill in handling clinical equipment.	1,3,4,5	K1 & K2
CO-3	Evaluate the hematological and histological parameters of biological samples.	2,3,4,5	K2 & K3
CO-4	Understand the mechanism of cardiogram, electroencephalography and ultrasonography	1,2,3,4	K2 & K4
CO-5	Develop skills in handling and labelling of histology specimens	2,3,4,5	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PEZO11B	Medical Laboratory Techniques	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	3	3	3	3	3	3	3	2	3
CO-2	3	3	3	2	3	3	2	3	3	3
CO-3	2	3	3	3	2	2	3	3	3	3
CO-4	3	2	2	3	3	3	3	3	3	2
CO-5	3	3	3	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Animal Feed Technology		24PEZO11C			
EC–IC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General objectives

To understand the techniques of processing of feed ingredients, various types of feed and strategies of feed storage additives.

Learning objectives:

LO	The learners will be able to
LO -1	Categorizing the components of foods
LO -2	Explain the digestion and metabolism of nutrients
LO -3	Outline the nutritional characteristics of foods
LO -4	Checking Protein concentrates, Food additives
LO -5	Formulating the feed for animals.

UNIT I - The Components of Foods

Animal food – Classification of animal food – Carbohydrates - Monosaccharides, Monosaccharides derivatives, Oligosaccharides, Polysaccharides and Lignin.Lipids- Fat, Glycolipids, Phospholipids, Waxes, Steroids and Terpenes.Protein- Amino acids and Peptides -Vitamins and Minerals.

UNIT II - The Digestion and Metabolism of Nutrients

Enzymes – Classification of enzymes, Nature of enzymes, Mechanism of enzyme action. **Digestion -** Digestion in Mono gastric Mammals, Microbial digestion in ruminants and other herbivores, alternative sites of microbial digestion, nutrient digestion and the environment **Metabolism** – Energy metabolism, Protein synthesis, fat Synthesis and carbohydrate synthesis.

UNIT III - The Nutritional Characteristics of Foods

Grass and forage crops- Grasses, Legumes, Other forages, Silage- Classification of silages, Nutritive value of silages, Whole crop cereal and legume silages. Hay, artificially dried forages, straws and chaff - Roots, tubers and related by-products- Cereal grains and cereal by-products.

UNIT IV - Protein Concentrates and Food Additives

Protein concentrates - Oilseed cakes and meals, Leguminous seeds, Animal protein concentrates, Single cell protein and synthetic amino acids. **Food additives**– Antibiotics, Probiotics, Oligosaccharides, Enzymes, Organic acids, Spray-dried plasma, Modifiers of rumen fermentation.

UNIT V - Feed Formulation

Need for feed formulation-square method-Linear programming - feed manufacturing (Basis of feed mill) – Feed stability-feed storage-feed spoilage (Bacterial and Fungal toxins)-factors affecting feed storage and nutrient loss.

Textbooks

1. P Mc Donald *et al.,* 2011, Animal nutrition, Seventh Edition,Prentice Hall

Reference Books

2. Pillai, TVR. and M.N.Kutty., 2005. Aquaculture: Principles and Practices, Wiley- Blackwell.
3. Michael, B.New.1985.Feed and feed technology.
4. CMFRI Bulletin-1:Feed Technology

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Identify, classify, and evaluate various feed ingredients used in animal nutrition, considering their nutritional composition and suitability for different animal species.	1,2,4,5	K1 & K3
CO-2	Demonstrate knowledge of different feed processing techniques including grinding, mixing, pelleting, and extrusion, and their impact on feed quality and animal performance.	1,3,4,5	K1 & K2
CO-3	Formulate balanced diets for different classes of animals based on their nutritional requirements, taking into account factors such as age, species, production stage, and environmental conditions.	1,2,3,4	K2 & K3
CO-4	Aware of current research and developments in animal feed technology, including innovations in feed additives, alternative ingredients, and sustainable feed production.	2,3,4,5	K2 & K4
CO-5	Analyze the economic implications and environmental impact of different feed ingredients and production methods, with a focus on sustainability and cost-effectiveness.	1,2,4,5	K4, K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course code	Title of the Course	Hours	Credits
I	24PEZO11C	Animal Feed Technology	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	3	3	3	3	2	3	3
CO-2	2	3	3	3	3	3	2	3	3	3
CO-3	3	3	2	2	3	3	3	3	3	2
CO-4	3	2	3	3	3	2	3	3	3	3
CO-5	3	3	3	2	3	3	3	2	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester - I	Poultry Farming		24PIZO11			
Elective–II-IDC-I			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

To equip students with comprehensive knowledge and practical skills necessary to successfully manage and operate a poultry farm.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the anatomy, physiology, and genetics of poultry.
LO-2	Learn about different poultry breeds and their characteristics.
LO-3	Understand feed formulation and the importance of balanced diets.
LO-4	Gain knowledge on poultry health management and disease prevention.
LO-5	Gain knowledge on poultry reproduction and breeding techniques.

UNIT I -Introduction to Poultry farming

General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming.

UNIT II –Farm Management

Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance.

UNIT III – Feed and Nutrition

Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.

UNIT IV – Poultry diseases

Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.

UNIT V – Handling and Hatching

Selection, care and handling of hatching eggs - Egg testing. Methods of hatching.- Brooding and rearing -. Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste.

Textbooks:

1. http://www.asciindia.com/BooksPDF/Small%20Poultry%20Farmer.pdf
2. https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf
3. http://ecoursesonline.iasri.res.in/course/view.php?id=335
4. https://swayam.gov.in/nd2_nou19_ag09/preview

Reference Books:

1. Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1stEdition. Write & Print Publications, New Delhi 2.
2. Jull A. Morley, 2007. Successful Poultry Management. 2ndEdition. Biotech Books, New Delhi"
3. Hurd M. Louis, 2003. Modern Poultry Farming. 1stEdition. International Book Distributing Company, Lucknow."

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the various practices in Poultry farming, needs for Poultry farming and the status of India in global market.	1,2,3,4	K2 & K3
CO-2	Able to apply the techniques and practices needed for Poultry farming.	3,4,5	K3 & K4
CO-3	Know the difficulties in Poultry farming and be able to propose plans against it.	1,3,4,5	K4 & K5
CO-4	Implement effective health management and disease prevention strategies.	2,3,4,5	K3 & K4
CO-5	Apply principles of poultry reproduction and breeding techniques.	1,2,3,4	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
I	24PIZO11	Poultry Farming	30	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	3	2	3	3	3	2	2	3	3	3
CO-3	2	3	3	2	2	3	2	3	3	3
CO-4	3	3	2	3	3	2	3	3	3	3
CO-5	3	2	3	3	2	3	3	3	3	2
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Developmental Biology		24PCZO21			
Core-IV			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	5

General Objective:

To provide students with a comprehensive understanding of the processes and mechanisms in development of embryos from fertilization to the formation of a fully developed organism.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human.
LO-2	Learn the principles, methods and applications of cryo-preservation of gametes and embryo.
LO-3	Understand cell-cell communication and the role of signaling pathways in coordinating development.
LO-4	Learn about the molecular signals and genetic pathways that govern embryonic development.
LO-5	Understand the development of major organ systems and tissues.

UNIT I - Development Pattern and Gametogenesis

Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Vitellogenesis.

UNIT II – Fertilization

Fertilization:Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitaion in mammals, Acrosome reaction. Sperm – egg interaction. Egg activation - Cortical reaction - Physiological polyspermy -

Fusion of male and female pronuclei - Post fertilization metabolic activation – Parthenogenesis- Types and significance of parthenogenesis.

UNIT III – Cleavage and gastrulation

Cleavage and gastrulation:Pattern of embryonic cleavage, mechanisms of cleavage, Factors affecting gastrulation, mechanisms and types of gastrulation in *Amphioxus*, Amphibians, Aves, Mammals Fate maps - (Amphibian and Chick), Epigenesis and preformation.

UNIT IV – Organogenesis and Neurulation

Embryonic Development: Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation: Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development: Anterior- posterior axis in determination in drosophila, Maternal effect genes - *Bicoid* and *Nanos* proteins; – pair rule genes; Homeotic genes.

UNIT V – Metamorphosis and Reproduction

Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Neoteny and pedogenesis. Regeneration: Types of regeneration in planaria and amphibian - wolffian regeneration; Factors stimulating regeneration – Biochemical changes associated with regeneration. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Induced ovulation in humans – Cryopreservation of gametes/embryos

Textbooks:

1. Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.
2. Slack J.M.W. 2012. Essential Developmental Biology (3rd Edition), Wily-Blackwell Publications, USA, pp-496.
3. Mari-Beffa, M. and J. Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.

Reference Books:

1. Balinsky, B. I. 1981. Introduction to Embryology (5th Edition), CBS College Publishers, New York, pp-782.
2. Gilbert. S. F. 2006. Developmental Biology, 8th Edition, INC Publishers, USA, pp-785.
3. Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Define the concepts of embryonic development	2,3,4,5	K1
CO-2	Observe various stages of cell divisions under microscope	1,2.3,4	K2 & K3
CO-3	Understand the formation of zygote	1,3,4,5	K4
CO-4	Differentiate the blastula and gastrula stages	2,3,4,5	K4 & K5
CO-5	Learn the distinguishing features of three different germ layers and formation of various tissues and organs	1,2,3,4,5	K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCZO21	Developmental Biology	75	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	2	3	3	3	3
CO-2	2	3	2	2	3	3	3	3	3	2
CO-3	3	2	3	3	2	3	2	3	3	3
CO-4	2	3	2	3	3	2	3	3	3	3
CO-5	3	3	2	3	3	3	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Biostatistics		24PCZO22			
Core-V			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	4	1	-	4

General Objective:

To equip students with the knowledge and skills necessary to apply statistical methods for the analysis of biological data.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the role and importance of biostatistics in biological sciences.
LO-2	Understand and apply measures of central tendency (mean, median, and mode) and measures of variability (range, variance, standard deviation) and interpret graphical representations of data (histograms, box plots, scatter plots).
LO-3	Gain skills in performing and interpreting linear and logistic regression analyses and Non-parametric tests.
LO-4	Learn about different probability distributions (normal, binomial, Poisson) and their applications.
LO-5	Gain knowledge of inferential statistical methods, including hypothesis testing and confidence intervals, t-test and ANOVA.

UNIT I -Biological Data

Definition, scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.

UNIT II – Descriptive Statistics

Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error and coefficient of variation.

UNIT III – Probability and Distributions

Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.

UNIT IV –Inferential statistics

Hypothesis testing: Student'*t*' test - paired sample and mean difference'*t*' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.

UNIT V – ANOVA and SPSS

Analysis of variance: one way and two way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).

Textbooks:

1. Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48.
2. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467.
3. Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859.
4. Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.
5. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.

Reference Books:

1. Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447.
2. Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407.
3. Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363.
4. Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount Publications, Tamil Nadu, pp-264.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Demonstrate a solid understanding of fundamental statistical concepts and methods.	1,2,3,4	K2 & K3
CO-2	Use descriptive statistics to summarize data.	2,3,4,5	K3 & K4
CO-3	Knowledge on various distribution types and perform probability measures.	1,2,3,4	K5 & K6
CO-4	Perform and interpret hypothesis testing and regression analyses.	1,2,3,5	K3 & K4
CO-5	Proficiently use statistical software to perform data analysis.	2,3,4,5	K3 & K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCZO22	Biostatistics	75	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	2	3	2	3	3	2	3	3	3	3
CO-3	3	3	3	3	2	3	3	3	3	2
CO-4	3	2	3	2	3	3	3	3	2	3
CO-5	2	3	3	3	2	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Lab Course in Developmental Biology		24PCZO2P1			
Core-P-III			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	1	-	3	2

General Objective:

This course aims to reinforce theoretical knowledge through experimental techniques, foster critical thinking, and enable students to conduct and analyze developmental biology research effectively.

Learning Objectives

LO	The learners will be able to:
LO-1	Translate theoretical concepts from developmental biology lectures into practical, hands-on experiments.
LO-2	Understand the relationship between theory and practice in the study of developmental biology.
LO-3	Identify and describe key developmental processes such as fertilization, cleavage, gastrulation, neurulation, and organogenesis.
LO-4	Develop skills in observing and documenting developmental stages and processes.
LO-5	Learn to handle and manipulate embryos from different model organisms

Experiments

Gametogenesis - Observation of gametes from gonadal tissue sections

1. Oogenesis:
    - Section through ovary of shrimp, fish, frog and mammals
2. Spermatogenesis:
    - Section through testis of shrimp, fish, calotes and mammals
3. Fertilization
    - Induced spawning in polycheate worm *Hydroids elegans*
    - *In vitro* fertilization and development in a polycheate worm *Hydroids elegans*
    - Observation of egg developmental stages in *Emerita emeritus*

4. Embryogenesis
    - Observation and whole mount preparation of the chick blastoderm - 18 hours of development
    - Chick embryonic stage - 24 hours of development
    - Chick embryonic stage - 48 hours of development
    - Chick embryonic stage - 72 hours of development
    - Chick embryonic stage - 96 hours of development
5. Histological observation: Section through various developmental stages in chick embryo
6. Experimental Embryology
7. Regeneration in Frog Tadpoles
    - Blastema formation
    - Demonstration of regenerative process in tadpole
8. Metamorphosis
    - Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine
9. Cryopreservation
    - Demonstration of cryopreservation of gametes of fin fish/shell fish

Spotters

1. Frog- T.S of testis and ovary, fertilized egg, yolk plug stage, neurula and tadpole
2. Slides on cleavage- chick cell – 2 cell,4 cell, 8 cell stages, blastula and gastrula
3. Types of placenta – discoidal placenta, diffuse placenta and cotyledonary placenta

References:

1. A.K. Datta, "Practical Manual of Medical Embryology", Current Books International, 2018
2. Inderbir Singh, "Human Embryology", Jaypee Brothers Medical Publishers", 2014

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells.	1,2,3,4	K1 & K2
CO-2	Identify the mounting of chick embryos in 24 hours, 48hours,72hours and 96 hours	2,3,4,5	K4 & K5
CO-3	Differentiate the different stages of frog including blastula and gastrula stages	1,2,3,4	K3 & K4
CO-4	Assess the influence of hormone on amphibian metamorphosis	1,2,3,4,5	K2 & K4
CO-5	Explain the female gametes in fish and frog	2,3,4,5	K2 & K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCZO2P1	Lab Course in Developmental Biology	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	2	3	3	3	3	2
CO-2	3	3	2	3	3	2	3	3	3	3
CO-3	2	2	3	3	3	3	3	3	3	2
CO-4	3	3	3	2	2	3	3	3	3	3
CO-5	2	3	3	3	3	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Lab Course in Biostatistics and Research Methodology		24PCZO2P2			
Core-P-IV			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :50	1	-	3	2

General Objective:

To equip students with practical skills and a solid understanding of statistical methods and research design principles applicable to biological sciences.

Learning Objectives

LO	The learners will be able to:
LO-1	Gain a thorough understanding of fundamental statistical concepts and terms.
LO-2	Learn to calculate and interpret measures of central tendency and variability.
LO-3	Understand how to summarize and describe data using tables, graphs, and charts.
LO-4	Learn to input data, perform statistical tests, and interpret output from statistical software.
LO-5	Learn to present findings clearly and effectively through written reports and oral presentations.

Experiments

1. Graphical Representation of Data (Bar diagram, Frequency polygon and ogive curve; Histogram, pictogram and pie chart)
2. Statistical analysis of mean, median and mode, variance, SD, SE, coefficient of variation using neem leaves and their graphical representation.
3. Calculation of correlation coefficient –length and width of neem leaves
4. Calculation of regression co-efficient using length and width of neem leaves.
5. Study of probability using cointoss (Two Coins)

6. Calculation of Normal, Binomial and Poisson distributions.
7. Test of significance (student'st-test) (Simple, Two Sample and Paired)
8. Analysis of variance: one way and two way classification
9. Processing data with statistical package.(SPSS)-Demonstration.
10. Select a topic and write a model research proposal.

Spotters

1.pHmeter 2.Colorimeter 3.Spectrophotometer 4.Chromatography 5.Electrophoresis 6.Regression Line 7. Harmonic and Geometric Mean 8. Data visualization using Stem and Leaf chart.

Reference Books:

1. S. K. Gupta, "Introduction to Biostatistics and Research Methods", Jaypee Brothers Medical Publishers (P) Ltd.,2003
2. K. P. Suresh, "Fundamentals of Biostatistics", Himalaya Publishing House,2009
3. B. K. Manjunath, "Statistical Methods in Biological and Medical Sciences", Ane Books Pvt. Ltd,2011

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Acquire knowledge to perform statistical calculation in biological data	1,3,4,5	K2
CO-2	Understand and observe as well as correctly identify working principles of different research techniques.	1,2,3,5	K3
CO-3	Develop handling - skills through the wet-lab course.	1,2,4,5	K6
CO-4	Learn the method of writing research proposal	1,2,3,5	K1 & K2
CO-5	Acquire skills to perform t-Test, ANOVA in Using SPSS	1,2,3,4,5	K5 & K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PCZO2P2	Lab Course in Biostatistics and Research Methodology	60	2

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	3	2	3	3	3
CO-2	2	3	2	3	2	3	3	3	2	3
CO-3	3	2	3	3	3	3	3	2	3	3
CO-4	3	3	3	2	3	3	3	3	2	3
CO-5	2	3	3	3	2	3	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Apiculture		24PEZO21A			
EC-IIIA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To provide students with comprehensive knowledge and practical skills related to beekeeping, bee biology, and the management of bee colonies for the production of honey and other bee products.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the historical and cultural significance of beekeeping.
LO-2	Study the anatomy, physiology, and behaviour of honey bees.
LO-3	Develop skills in constructing, maintaining, and managing beehives.
LO-4	Learn about common pests and diseases that affect honey bees and about integrated pest management
LO-5	Understand the quality control measures and standards for honey production.

UNIT I –Introduction to Apiculture

Introduction to Apiculture.History, classification, types, life Cycle of different species of Honey Bees and their behavioural patterns. Social organization of bee colony

UNIT II –Bee-keeping Mechanism

Bee-keeping system, tools and equipment's needed for bee keeping. Types of bee hives, structure and functional features.Criteria for site selection for apiculture and factors affecting them.

UNIT III – Bee enemies and diseases

Identification, characteristics and Preventive measures to be taken against of different bee enemies. Diseases affecting honey bees and their control measures. Colony collapse disorder and its management.

UNIT IV – Bee products

Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom.Harvesting, Processing, Packaging and Marketing of bee products.

UNIT V – Apiculture and Entrepreneurship

Apiculture industry around the world and Role of Central Bee Research & Training institute in India.Apiculture as an Entrepreneurial venture.

Textbooks:

1. Caron, D.W. 2013 (revised from 1999). Honey Bee Biology and Beekeeping. Wicwas Press. Cheshire, CT, 368 pp.
2. Kaspar, R., C. Cook, and M. D. Breed. 2018. Animal Behaviour 142: 69-76.

Reference Books:

1. Singh, D., Singh, D. Pratap. 2006. A Handbook of Beekeeping. AGROBIOS (INDIA)
2. Sharma P.L. and Singh, S.H. Book of Bee keeping.
3. Cherian and Ramanathan, S. Bee keeping in south India.
4. Prospective in Indian Apiculture - R.C. Mishra.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Clear understanding of morphology, life cycle, characteristics of honey bees and bee keeping.	1,2,4,5	K1 & K2
CO-2	Acquired skills to perform bee keeping from managing colonies of bees as an Entrepreneurial venture.	1,3,4,5	K3& K4
CO-3	Knowledge on the harvesting, preserving and processing of bee products	2,3,4,5	K3 & K4
CO-4	Develop business plans and marketing strategies for beekeeping enterprises.	1,2,3,5	K2 & K4
CO-5	Gain the knowledge in sustainable practices that protect the environment and bee populations.	2,3,4,5	K3& K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
II	24PEZO21A	Apiculture					60	3		
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	2	3	3	3	3	3	3	2	3	3
CO-2	3	3	2	3	3	3	2	S	3	3
CO-3	3	2	3	2	3	2	3	3	3	3
CO-4	2	3	2	3	3	3	3	3	2	3
CO-5	3	3	3	3	2	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Vermiculture		24PEZO21B			
EC-IIIB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To provide students with comprehensive knowledge and skills related to the cultivation and management of earthworms for composting organic waste and producing vermicompost.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the history and significance of vermiculture in sustainable agriculture and waste management.
LO-2	Study the anatomy, physiology, and behavior of earthworms.
LO-3	Develop skills in designing, constructing, and maintaining vermiculture systems (worm bins and beds).
LO-4	Understand the process of feeding and managing organic waste in vermiculture systems.
LO-5	Study the economics of vermiculture, including market analysis, business planning, and financial management.

UNIT I -Taxonomy and Anatomy of Earthworms

Earthworms - Taxonomic position, external features - shape, size, colour, segmentation, setae & clitellum. Body wall, coelom-locomotion,digestive, circulatory, respiratory, excretory & nervous system. Reproductive system-Male & Female, copulation, cocoon formation & fertilization, development of earth worm. Vermitechnology- Definition, history, growth and development in other countries & India, significance.

UNIT II – Introduction to Vermiculture

Vermiculture - definition, common species for culture; Environmental parmeters; culture methods – wormery - breeding techniques; indoor and outdoor cultures - monoculture and polyculture - merits and demerits.

UNIT III – Methods of Vermicomposting

Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows, top fed windrows, wedges & bin method, harvesting the compost, storage.

UNIT IV – Management and Applications

Applications of vermiculture - Vermiculture Bio-technology, vermicomposting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration.

UNIT V – Marketing and Economic Importance

Potentials and constraints for vermiculture in India. Marketing the products of vermiculture - quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing. Economic importance of Earthworms: In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food.

Textbooks:

1. https://agritech.tnau.ac.in/sericulture/
2. https://www.agrifarming.in/vermiculture-process-techniques-worm-farming
3. Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication company.

Reference Books:

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2. Bhatnagar&Patla, 2007. Earthworm vermiculture and vermin-composting, KalyaniPublishers,New Delhi
3. Mary Violet Christy, 2008. Vermitechnology,MJP Publishers, Chennai.
4. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman,India.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	To understand the various practices in vermiculture.	1,3,4,5	K1 & K2
CO-2	Able to apply the techniques and practices needed for vermiculture.	1,2,4,5	K3& K4
CO-3	To know the difficulties in Vermiculture and be able to propose plans against it.	1,2,3,4,5	K3 & K4
CO-4	Apply integrated pest management and disease prevention strategies.	1,2,4,5	K3& K4
CO-5	Understand the economic factors influencing the vermiculture industry.	1,2,3,4	K2& K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PEZO21B	Vermiculture	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	3	2	3	3	3
CO-2	3	2	3	2	3	3	3	2	3	3
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	2	3	2	3	2	3	3	2	3	3
CO-5	3	2	3	3	3	3	3	3	3	2
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Microbiology		24PEZO21C			
EC-IIIC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General objective:

To impart knowledge on classification, characteristics and significance of microorganisms and to provide knowledge on development of microbiology and industrial application of microbes.

Learning Objectives

LO No.	The learners will be able to
LO-1	Explain the history and scope in microbiology.
LO-2	Understand the growth kinetics of microorganisms.
LO-3	Examine the structure and functions of genetic materials in microbes.
LO-4	Assess the different types of microbial diseases.
LO-5	Construct the steps involved in preservation techniques.

UNIT I - Classification of Microbes

History and scope of microbiology - classification of bacteria, fungi, protozoa and virus; Morphology and fine structure of bacteria, Virus and fungi; Isolation– pure culture techniques, identification and maintenance of microbes.

UNIT II - Microbial Growth

Requirements for growth: physical and culture characteristics, culture media curve, measurement of microbial growth, growth curve and growth kinetics; microbial control:physical and chemical methods- methods of estimation of microorganisms in soil, water and air – isolation and identification of bacteria – biochemical tests.

UNIT III - Microbial Genetics

Structure and functions of genetic material – transfer of genetic information – transformation, transfection, conjugation, retro transfer, transduction and genetic recombination, regulation of gene expression in bacteria.

UNIT IV- Microbial Diseases

Protozoan diseases: Plasmodium, Entamoeba; Fungal diseases: Mycotoxicosis, Aspergillosis and Dermatomycosis; Bacterial diseases: Meningitis, Cholera, Typhoid, Gonorrhea and Syphilis; Viral diseases – Polio, Hepatitis B, Rabies and AIDS – Mode of transmission, diagnosis and treatment –Types of vaccines.

UNIT V- Applied Microbiology

Fermentation – definition and types; bioconversion, bio remediation – industrial production of Penicillin, ethanol, vinegar, vitamin B12 – Citric acid and glutamic acid production; Food microbiology – food spoilage and food preservation, fermented foods, probiotics and prebiotics.

Text Books

1. Ananthanaryanan, T and Paniker, J.C.K. 2000. Text Book of Microbiology Oriental Longman Ltd., Madras.
2. Dubey, H.C., 2004. A text book of fungi, bacteria and viruses, Vikas Publishing House.

Reference Books

1. R. C. Dubey and D. K. Maheshwari, 2009. A textbook of microbiology, S. Chand & Company, New Delhi.
2. Prescott, Harley and Klein, Microbiology, 2004. 6th Edition, McGraw-Hill Higher Education,, New York.
3. R. Y. Stainer, J. L. Ingraham, M. L. Wheelis and P. R. Painter, 2007, General microbiology, Macmillan India Ltd.
4. S.S. Purohit, Microbiology: 2002. Fundamentals and applications, Agro Bios, 6th revised Edition, India.
5. N. Kannan, 2002, Laboratory Manual in General Microbiology, Palani Paramount Publications.
6. J. Cappuccino and N. Sherman, 2013, Microbiology: A laboratory Manual, Pearson Benjamin Cummings, 10th Edition.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Demonstrate a thorough understanding of the fundamental principles and concepts in microbiology, including microbial structure, function, metabolism, and genetics.	1,2,4,5	K1 & K3
CO-2	Describe the diversity of microorganisms, including bacteria, viruses, fungi, protozoa, and archaea, and their roles in various environments and biological processes.	2,3,4,5	K1,K2 & K3
CO-3	Develop proficiency in basic and advanced laboratory techniques used in microbiology, including microscopy, culture methods, biochemical tests, and molecular biology techniques.	1,2,3,4,5	K1, K2 & K3
CO-4	Understand the mechanisms of microbial pathogenesis, including virulence factors, host-pathogen interactions, and the immune response to microbial infections.	2,3,4,5	K2,K3 & K4
CO-5	Evaluate the mechanisms of action of antimicrobial agents, mechanisms of resistance, and strategies for combating antimicrobial resistance.	1,2,3,4,5	K4, K5 & K6

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credits
II	24PEZO21C	Microbiology	60	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	2	3	3	2	3	3	2	3	3
CO-2	2	3	3	3	3	2	3	3	3	3
CO-3	3	3	2	2	3	3	3	3	3	3
CO-4	3	2	3	3	2	2	3	3	3	3
CO-5	3	3	2	2	3	3	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Semester – II	Bio - Composting		24PIZO21			
EC-IV-IDC-II			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

To equip students with a comprehensive understanding of the principles, methods, and practices of biocomposting.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the significance and history of biocomposting in sustainable agriculture and waste management.
LO-2	Study the microbiological and biochemical processes involved in the decomposition of organic materials.
LO-3	Understand the advantages and disadvantages of different composting methods.
LO-4	Acquire knowledge related to applications ofbiocomposting.
LO-5	Learn about sustainable biocomposting practices that promote environmental conservation.

UNIT I –Introduction to Composting

Introduction to Composting, Biocomposting - Definition, Types of biocomposting and ecological importance. Composting at home

UNIT II – Different types and Methods

Types of biocomposting technology - Field pits/ground heaps/ tank/large-scale/batch and continuous methods.

UNIT III – Requirements for Biocomposting

Materials required for Biocomposting, Preparation of biocompost pit and bed using different amendments.

UNIT IV – Applications of biocomposting

Applications of biocompost in soil fertility maintenance, promotion of plant growth, value added products, waste reduction.

UNIT V –Biocomposting and Entrepreneurship

Establishments of small biocompost unit - project report proposal for Self Help Group (Income and employment generation).

Reference Books:

1. Bikas R. Pati&Santi M. Mandal (2016). Recent trends in composting technology.
2. Van der Wurff, A.W.G., Fuchs, J.G., Raviv, M., Termorshuizen, A.J. (Editors). 2016. Handbook for Composting and Compost Use in Organic Horticulture.
3. BioGreenhouse COST Action FA 1105,

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Gained knowledge on the process of biocomposting	1,2,3,4,5	K1 & K2
CO-2	Ability to evaluate the different methods of biocomposting	1,2,4,5	K4& K5
CO-3	Gained knowledge in handling the materials utilized in biocomposting methods	1,3,4,5	K3 & K4
CO-4	The ability to demonstrate biocomposting techniques for various end applications like solid waste management, industrial waste recycling using sugarcane bagasse, etc.	1,2,3,4	K4& K5
CO-5	Knowledge, gain on the economic cost of establishing small biocompost units in the cottage industry.	1,2,4,5	K2& K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	24PIZO21	Bio-composting				30	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	2	3	3	3	3	3
CO-2	3	3	2	3	3	3	3	2	3	3
CO-3	2	3	3	2	3	3	2	3	3	3
CO-4	3	2	2	2	3	3	3	3	3	2
CO-5	3	3	2	2	2	3	3	2	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

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Signature: Head of the Department

Semester – II	Research Methodology		24PSZO21			
SEC-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To provide students with a comprehensive understanding of the principles, design, and application of instruments used in biological research.

Learning Objectives

LO	The learners will be able to:
LO-1	Understand the role and importance of GLP in biological and medical sciences
LO-2	Gain knowledge of the physical, chemical, and biological principles of various instruments.
LO-3	Explore the applications of bioinstrumentation in biological research, clinical diagnostics, and therapeutic monitoring.
LO-4	Gain skills in handling of various biological research devices.
LO-5	Understand the principles of Animal Cell Culture.

UNIT I -GLP and Instrumentation

Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry.

UNIT II –Histochemistry and Bioinformatics

Histology, Histochemistry, Bioinformatics and Electron microscopy.

UNIT III – Microscopy

Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy.

UNIT IV – Separation Techniques

Centrifuges, Chromatography, Electrophoresis, ELISA and blotting.

UNIT V – Cell Culture

Principles and Applications of tracer techniques in biology, Animal cell culture techniques.

Textbooks:

1. Chandler, D.E. and Roberson R.W. 2009. Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440.
2. Engelbert, B. 1960. Radioactive Isotopes in Biochemistry, Elsevier Applied Science, pp-376.
3. Wolf, G. 1964. Isotopes in Biology, Academic Press, pp-173.
4. Srivastava, B. B. 2005. Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.
5. Pantin, C. F. A. 1948. Microscopical Techniques, Cambridge University Press, London.

Reference Books:

1. Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758.
2. Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.
3. Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.

Course Outcomes

CO	Upon completion of this course, students would have learned to:	PSOs Addressed	Cognitive Level
CO-1	Understand the implications of GLP	1,2,3,4	K2 & K3
CO-2	Learn the working principles of different instruments	2,3,4,5	K1 & K3
CO-3	Gain the knowledge on techniques of histology and histochemistry	1,3,4,5	K1 & K4
CO-4	Acquire knowledge on the basic principle and application of various modules of light and electron microscopy	1,2,4,5	K1 & K3
CO-5	Acquire skills related to animal cell culture techniques.	2,3,4,5	K4 & K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	24PSZO21	Research Methodology				60	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	3	3	3	3	3	3	2
CO-2	3	3	3	2	3	2	3	3	3	3
CO-3	2	3	3	3	2	3	2	3	3	3
CO-4	3	3	2	3	3	3	3	2	3	3
CO-5	3	3	3	3	2	2	3	3	3	3
	STRONG (3), MEDIUM (2) and LOW (1)									

Prepared by Name: Checked by

Signature: Head of the Department