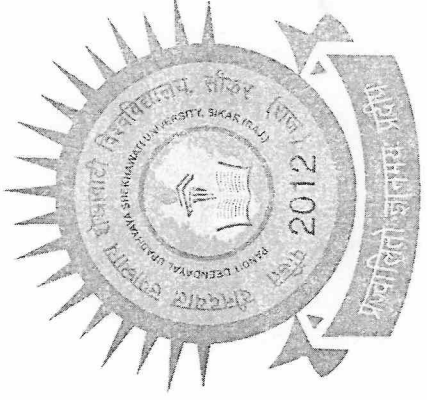


As per NEP 2020
M.Sc. Zoology
(Effective from Academic Year 2024-2025 onwards)



Pandit Deendayal Upadhyaya Shekhawati University

Sikar (Rajasthan) 332024

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Curriculum Structure									
Session 2024-2025 onwards									
Name of the Program: Master of Zoology									
Year: First							Semester: I (Pawas)		
Course Code	Course Title	Contact Hrs per Week	Credits			Weightage (%)			
			L	T	P	CWS	MTE	ETE	
Discipline Specific Core (DSC):									
24MZO9101T	Structure and Function of Invertebrates	4	0	0	0	4	10	20	70
24MZO9102T	Mendalian, Microbial and Human Genetics	4	0	0	0	4	10	20	70
24MZO9103T	Fundamentals of Biochemistry	4	0	0	0	4	10	20	70
24MZO9104P	Zoology Laboratory	0	0	0	8	4	-	-	100
Discipline Specific Elective(DSE): (Select any one)									
24MZO9105T	Wild Life Biology	4	0	0	0	4	10	20	70
24MZO9106T	Animal Biotechnology	4	0	0	0	4	10	20	70
24MZO9107T	Methods in Biostatistics	4	0	0	0	4	10	20	70
Value Added Course(VAC):									
		--	--	--	--	2	--	--	--
Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):									
		--	--	--	--	--	--	--	--
	Total					22			

Summary: I Semester (Pawas)			Credits
S.N.	Particulars		
1.	Discipline Specific Core(DSC):	16	
2.	Discipline Specific Elective (DSE):	04	
3.	Value Added Course (VAC):	02	
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):	00	
Total		22	
\$CW (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.			

Note: VAC to be selected from the list of VAC courses for PG, given on University website.

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Curriculum Structure									
Session 2024-2025 onwards									
Name of the Program: Master of Zoology					Semester: II (Vasant)				
Year: First									
Course Code	Course Title	Contact Hrs per Week			Credits	Weightage (%)			ETE
		L	T	P		CWS	MTE		
Discipline Specific Core (DSC):									
24MZO9201T	Research Methodology	4	0	0	4	10	20	70	
24MZO9202T	Cell and Molecular Biology	4	0	0	4	10	20	70	
24MZO9203T	Animal Physiology	4	0	0	4	10	20	70	
24MZO9204P	Zoology Laboratory	0	0	8	4	-	-	100	
Discipline Specific Elective(DSE):									
24MZO9205T	Basic of Immunology	4	0	0	4	10	20	70	
24MZO9206T	Biology of Insecta	4	0	0	4	10	20	70	
24MZO9207T	Fish and Fisheries	4	0	0	4	10	20	70	
Value Added Course(VAC):									
---	---	---	---	---	2	---	---	---	---
Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):									
---	---	---	---	---	---	---	---	---	---
Total					22				

Summary: II Semester (Vasant)			Credits
S.N.	Particulars		
1.	Discipline Specific Core(DSC):	16	
2.	Discipline Specific Elective (DSE):	04	
3.	Value Added Course (VAC):	02	
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):	00	
Total		22	
\$CW/ (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.			

Note: VAC to be selected from the list of VAC courses for PG, given on University website.


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Curriculum Structure											
For Session 2025-2026 onwards											
Name of the Program: Master of Zoology				Semester: III (Pawas)							
Year: Second		Course Code	Course Title	Contact Hrs per Week		Credits		Weightage (%)			
				L	T	P			CW\$	MTE	ETE
Discipline Specific Core (DSC):											
		24MZO9301T	Tools and Techniques	3	0	0	3	10	20	70	
		24MZO9302T	Evolution and Biology of Chordates	3	0	0	3	10	20	70	
		24MZO9301P	Zoology Laboratory	0	0	4	2	---	---	100	
Discipline Specific Elective (DSE): Select one Group (It will remain same in semester IV)											
Group A: Environmental Biology											
		24MZO9303T	Concepts and Approaches to Ecosystem	4	0	0	4	10	20	70	
		24MZO9304T	Environmental Education, Management and Regulations	4	0	0	4	10	20	70	
		24MZO9305T	Environmental Toxicology and Environmental Health	4	0	0	4	10	20	70	
		24MZO9302P	Environmental Biology Laboratory	0	0	8	4	10	20	70	
Group B: Entomology											
		24MZO9306T	Phylogeny, Taxonomy and Evolution of Insects	4	0	0	4	10	20	70	
		24MZO9307T	Morphology And Physiology of Insects	4	0	0	4	10	20	70	
		24MZO9308T	Development of Insects and Medical and Applied Entomology	4	0	0	4	10	20	70	
		24MZO9303P	Entomology Laboratory	0	0	8	4	10	20	70	
Group B: Cell Biology											
		24MZO9309T	Cellular Membrane Structure and Function	4	0	0	4	10	20	70	
		24MZO9310T	Cellular Physiology and Regulatory Mechanism	4	0	0	4	10	20	70	
		24MZO9311T	Radiogenomics and Radiomics Integration	4	0	0	4	10	20	70	
		24MZO9304P	Cell & Molecular Biology Laboratory	0	0	8	4	10	20	70	
Value Added Course (VAC):											
		---	---	--	--	--	2	--	--	--	
Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):											
		---	---	--	--	--	--	--	--	--	
		Total					26				

Pawas Semester III

Summary: III Semester (Pawas)			Credits
S.N.	Particulars		
1.	Discipline Specific Core (DSC):		08
2.	Discipline Specific Elective (DSE):		16
3.	Value Added Course (VAC):		02
4.	Seminar/Internship/Apprenticeship/Project/Community Outreach (S/I/A/P/C):		00
Total			26
\$CW (Class work): It would include attendance, class test/quiz test/assignments, ppt, play, learn by fun activities etc.			

Note: VAC to be selected from the list of VAC courses for PG, given on university website.


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Semester - I**Learning Objectives**

- This course is aimed towards generating fundamental knowledge, concepts related to Non Chordates
- To make students aware about the diversity of Animals present on the planet and how are they possibly related to each other in light of evolution.
- To make students aware about the structure and function of invertebrates

Learning Outcomes

By studying this course students will gain basic knowledge on

- The diversity of animals
- Their general characteristics
- Various groups of animals and their structure, function and evolutionary relationships
- Basic principles and concepts of evolution that contribute to animal diversity

Course Title:	Structure and Function of Invertebrates	Course Code: 24MZO9101T
Total Lecture hour 60		Hours
Unit I	Origin of Protozoa, parazoa and metazoa. Origin of radiata and bilateria. Origin, characters and types of metamerism. Origin and evolution of coelom. Locomotory organs and mechanisms of locomotion in Nonchordates, flight mechanism of insects, modification of foot organelles in Mollusca., Patterns of feeding and digestion in lower metazoan. Filter feeding in polycheata, Mollusca and Echinodermata.	20
Unit II	Organs of respiration: Gills, lungs and trachea. Mechanism of respiration, respiratory pigments, Excretory and osmo-regulatory organs and their mechanisms in nonchordates.	13
Unit III	Nervous system in nonchordates : Primitive nervous system- Coelenterata and Echinodermata, Aadvanced nervous system: Annelida, Crustacea, Insecta and Mollusca. Vision in insects, Mouth parts of Insects.	12
Unit IV	Reproduction: Larval forms of free-living and parasites nonchordates, Evolutionary significance of larval forms, Introduction to minor phyla, their salient features and characters, Origin and significance of Mesozoa, Rotifera Rhynchocoela and Sipunculida.	15
Reference Books:		
1	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science	
2	Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson	
3	Richard C Brusca, Gonzalo Giribet, Wendy Moore Invertebrates 4th Edition Oxford University Press	
4	Richard Fox , Robert D. Barnes, Edward E. Ruppert, Invertebrate Zoology: A Functional Evolutionary Approach, Brooks/Cole; 7th edition edition 2003	
5	Hyman, L.H. Invertebrate Series (Recent edition)	
6	Parker JJ and WA Haswel Textbook of Zoology. Vol I and II	
7	Kotpal, R.L. 2022 Series of Invertebrates. Rastogi Publication, Meerut.	

Learning Objectives

The learning objectives of this course are as follows:

- to be able to list some of the distinguishing features of prokaryotes versus eukaryotes.
- to provide an understanding of the basic patterns of inheritance.
- to explain how genotype is related to phenotype.
- to describe how a mutation can change the phenotype.

Learning Outcomes

By studying this course, students will be able to

- Enhance knowledge of the basic principles of inheritance.
- Develop analytical skills and critical thinking through pedigree analysis.
- Understand the mechanism of gene transfer and mapping in both prokaryotes and eukaryotes.



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- Learn the mechanisms of mutations and harmful and beneficial effects of mutagens, which help evolve new species over time.
- Be able to grasp basic concepts of human chromosomal disorders.

Course Title:	Mendelian, Microbial and Human Genetics	Course Code: 24MZ09102T
Total Lecture hour 60		
Unit I	Mendelian principles : Dominance, segregation, independent assortment. ,Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian principles:Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.	Hours 15
Unit II	Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids,. Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics : Methods of genetic transfers transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.	15
Unit III	Human genetics : Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics : Polygenic inheritance, heritability and its measurements, QTL mapping, Basis of Sex determination: Genetic and environmental; Sex determination in <i>Drosophila</i> and human; Mechanism of dosage compensation..	15
Unit IV	Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis,Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications., Recombination Homologous and non-homologous recombination including transposition:Transposons in bacteria, Ty elements in yeast, Ac-Ds elements in maize, P elements in <i>Drosophila</i> , Transposons in humans, Significance of Transposons	15
Reference Books:		
1	Principles of Genetics, Grdner E.J., VIII edition, Simmons M.J. and Snustad D.P, Willey India, 2008.	
2	Concepts of Genetics. XI edition. Klug WS, Cummings M.R., Spencer C.A. Benjamin Cummings, 2009.	
3	Genetics- A Conceptual Approach. Pierce B.A. W.H. Freeman & Co., NY, 2008.	
4	A Conceptual Approach. Russell P. J. III edition. Benjamin Cummings, 2009.	
5	Genetics of populations, Hedrick, R. W. Jones and Bartelt publisher, Sudbury, Massachuslts.	
6	Human Genetics: problems and approaches, Vogel F and Motulsky A. Springer Verlof, 1997.	
7	Human Molecular Genetics, Strachan T and Read A, III ed. Garland Science, 2003	
8	Snustad, D.P., Simmons, M.J. (2019). Principles of Genetics. V Edition. John Wiley and Sons In	

Learning Objectives

The learning objectives of this course are as follows:

- to be able to list some of the distinguishing features of prokaryotes versus eukaryotes.
- to provide an understanding of the basic patterns of inheritance.
- to explain how genotype is related to phenotype.
- to describe how a mutation can change the phenotype.

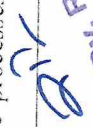
Learning Outcomes

By studying this course, students will be able to

- Enhance knowledge of the basic principles of inheritance.
- Develop analytical skills and critical thinking through pedigree analysis.
- Understand the mechanism of gene transfer and mapping in both prokaryotes and eukaryotes.
- Learn the mechanisms of mutations and harmful and beneficial effects of mutagens, which help evolve new species over time.
- Be able to grasp basic concepts of human chromosomal disorders.

Course Title:	Fundamentals of Biochemistry	
Total Lecture hour 60		Course Code: 24MZ09103T
Unit I	Structure of atoms, molecules and chemical bonds. , Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins)., Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.), Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties)	Hours
Unit II	Proteins: Covalent properties of protein: Structure and chemistry of amino acid, isolation and purification of protein, protein sequencing, covalent modifications, protein splicing, Secondary and tertiary structures of proteins, peptide and peptide bonds, Ramchandran plots and amino acid properties, common secondary structures, protein tertiary structure and folding patterns, common tertiary structural motifs, Protein folding and thermodynamics. Levinthal paradox, Molten globule, Chaperon assisted protein folding, Protein misfolding disease allostery (Hemoglobin), Myoglobin structure and oxygen binding, Hemoglobin subunits cooperatively, The Hill coefficient, Quaternary structural change and Sickle cell anemia.	13
Unit III	Carbohydrates: Structure and biological importance: Monosaccharides, Oligosaccharides, Polysaccharides (Storage and structural polysaccharides, glycosaminoglycans), Glycoconjugates (glycoprotein and proteoglycans). Lipids: Fatty acids: Structure, nomenclature, acyl glycerols, wax, phospholipids, sphingolipids, glycolipids, lipoproteins, Terpenoids and sterols: Structure, Properties and functions, Functions of lipids. Enzymes: Enzyme as biocatalyst, Enzyme kinetics, Mechanism of enzyme catalysis, Co-enzymes and co-factors, Isozymes, Enzyme inhibition, allosteric enzyme. RNA catalysis: chemistry and structure of ribozymes.	17
Unit IV	Metabolism: Catabolism, anabolism, metabolic pathway, regulation, concept of free energy, Carbohydrate metabolism: Enzymatic reaction, regulation importance of Glycolysis, Citric acid cycle, Oxidative phosphorylation and mechanism of ATP biosynthesis., Pentose phosphate pathway, glycogenolysis, Lipid metabolism: fatty acid oxidation and biosynthesis, Beta-oxidation. Amino acid metabolism: Catabolism of amino acid, Transamination, Deamination biosynthesis of non essential amino acid, fate of carbon skeleton, Nucleotide metabolism : Defradation of purine and pyrimidine nucleotides, biosynthesis (de novo, salvage pathways) of purine and pyrimidine nucleotides. Inborn error of metabolism	15
Reference Books:		
1	Biochemistry, Albert's R.H. Frey, P.A. and Jencks, W.P. Jones, and Bartlett Publisher, Boston/London 1992.	
2	Lehninger Principles of Biochemistry, Nelson D.L. And Cox, M.M. Acmillan/Worth Publishers 2021, 8 th edition	
3	Biochemistry, Berg J.M, Stryer L. et al. W.H. Freeman and Co. New York 2023, 10 th edition	
4	Fundamentals of Biochemistry, Voet D., Voet J.G. and Pratt C.W. Johan Wiley and Sons Inc. New York, 1999.	
5	Principles of Biochemistry, Horton, H.R. Morsanl. A Scringecour, K.G., Perry, M.D. Rawn, J.D. Pearsons Educations, International, 2011, 5 th edition	
6	Principles of Biochemistry, Zubay G.L. Pearson W. W. and Vence. D.E. Win. C Brown Publishers, Oxford, England 2020, 5 th edition	
7	Harper's Biochemistry, Murray, Granner, May Rodwell, McGraw Hill Publication, 2022, 32 th edition.	

Course Title:	Zoology Laboratory	Course Code: 24MZ09104P
1	Collection and Culture Methods Collection of animals from their natural habitat during field trips. e.g.. Amoeba, Paramecium, Euglena, Planaria, earthworm. Daphnia, Cyclops. etc. Culture of Paramecium in the laboratory and study of its structure. life processes and behaviour in the living state.	


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2	Anatomy: - Leech : Alimentary canal, nephridial and reproductive system - Crab: Nervous system. - Grasshopper: Nervous system and reproductive system. - Aplysia, Sepia and Loligo- Nervous system. - Sea Urchin - Aristotle's lantern. - Holothuria ~ General anatomy, alimentary canal. - Mouth parts of Insects (Butterfly / House Fly / Wasp / Honey Bee / Mosquito or any available). - Sting Apparatus: Wasp / Honey Bee ** Dissections may be demonstrated using computer software.
	Collection, culture, live study & permanent mounting: <i>Amoeba, Paramecium</i> <i>Hydra</i>, Obelia colony and medusa. - Trematodes. (. estodes and Nematodes.) - Permanent Mounting - <i>Sertulria</i>, <i>Companularia</i>, <i>Cercaria</i>, <i>Daphnia</i>, <i>Cyclops</i>, <i>Zoea</i>, <i>Megalopa</i>, <i>Mysis</i>, <i>Lucifer</i> Parapodium of <i>Nereis</i>
3	Study of Specimen: Spongilla Leucosolenia Sycon Euspongia Euplectella Hyalonema Physalia Porpita Sea anemone(Metridium) Alcyonium Gorgonia Pennetula Renilla Jelly Fish Beroe Cestum Ctenoplana Dugesia/Plannaria Taenia Solium Ascaris Male Ascaris Female Aphrodite Arenicola Chaetopterus Sabella Polynoe Eunice Neries Heteroneries Acanthobdella Pantobdella Polygordius Serpula Bonellia Sipunculus Lingula Apus Balanus Crab Cray Fish Astacus Eupagarus Sacculina with Host Desert Locust Squilla Silk Moth with Development Stage Lac Inset with Development Stage Millipede Peripatus Aplysia Dentallium Chiton Doris Limex Argonauta Nautilus Neopilana Solen Mantis White Grub Pearl Oyester Cyprea Pentaceros Echinus Ophiothrix Antedon Cucumaria, Star Fish,
4	Study of Permanent Slide: Radiolarian and Foraminifera ooze, Euglena, and Paramecium, Binary fission and Conjugation in Paramecium, Monocystis, Nyctotherus Gemmule Sponge spicules, V.S. Sycon, T.S. Sycon, Obelia medusa, Miracidium, Redia and Cercaria larvae of Fasciola, Scolex of Taenia, Mature and gravid proglottids of Taenia solium, Dracunculus Enterobius Wuchereria T.S. of Leech through crop pockets, Trochophore larva of Daphnia Cyclopoid Nauplius, Zoea and Megalopa , Veliger and Glochidium larva of Mollusca, T.S. of arm of star fish, Bipinnaria and Auricularia larva, T.S. Balanoglossus through collar and proboscis, Tornaria larva (Charts and Photographs can be used)
5	Permanent Preparation and Study of the following Paramecium, Euglena, forminiferous shells, sponge spicules, spongin fibres, gemmul . Hydra, Obelia colony and medusa. Parapodium of Nereis and heteronereis, ovary, nephridia, nerve ring and setae of earthworm salivary glands and trachea of Cockroach, Cyclops and Daphnia (Any other as per the availability)
6	Visit to local area and study of observed non-chordates,
1	Kotpal, R.L.2022 Series From Phylum-Protozoa to Echinodermata, Rastogi Publication, Meerut
2	Verma P. S. A Manual of Practical Zoology: Invertebrates. S Chand Publication
Genetics and Biochemistry Practical	
7	Simulation exercises using beads or seeds to study the gene interactions: 9:3:4; 12:3:1; 9:7; 9:3:3:1 (comb shapes in roosters) and verification of ratios by using chi- square analysis. Pedigree analysis of Autosomal Dominant trait, Autosomal recessive trait, X-linked Dominant traits, X-linked recessive traits, Y-linked traits and mitochondrial traits Use of probability in solving problems of genetics (Sum rule, Multiplication rule & Binomial expansion). Gene mapping (order and distance) using data from interrupted mating experiments in bacteria. .Linkage maps based on data (two - point and three - point crossing over) from Drosophila

Unit III	Zoological Parks: formation, management, food and feeding of captive animals and zoo sanitation. Community reserves and sacred groves. Red data book and IUCN categories: Extinct, Extinct in wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated. Some important reptilian species: Marsh crocodile (<i>Crocodylus palustris</i>), Indian Python (<i>Python molurus</i>), Red Crowned Roofed Turtle (<i>Kachuga kachuga</i>). Important bird species: Indian peafowl (<i>Pavo cristatus</i>), Siberian white crane (<i>Grus leucogeranus</i>), White-rumped vulture (<i>Gyps bengalensis</i>)	15
Unit IV	Important mammalian species: Asiatic lion (<i>Panthera leo</i>), Tiger (<i>Panthera tigris</i>), Leopard (<i>Panthera pardus</i>), Indian pangolin (<i>Manis crassicaudata</i>), Sloth bear (<i>Melursus ursinus</i>), Gaur (<i>Bos gaurus</i>), Asian elephant (<i>Elephas maximus</i>) Captive breeding and propagation, rehabilitation of animals. Wildlife forensics: Nature of wildlife crimes, investigations and scientific processes. Mammalian pug and hair analysis. DNA banks for endangered animals. Molecular markers used in wildlife forensics. Conservation ethics and values	15
Reference Books:		
1	Hunter ML, Gibbs JP, Popescu VD. 2021. Fundamentals of Conservation Biology. 4 th edi. Wiley-Blackwell.	
2	Vardinale B, Primack R, Murdoch J. 2019. Conservation Biology. 1 st edi. Oxford University Press.	
3	Sher A. 2022. An introduction to conservation biology. 3 rd edition. Oxford University Press	
4	Primack RB, Sher A. An introduction to conservation biology. 1 st edition. Oxford University Press	
5	Sodhi NS, Ehrlich PR. 2010. Conservation Biology for all. Oxford University Press.	
6	Dyke FV. 2008. Conservation Biology: Foundation, concepts, applications. Springer	
7	Suggested E-resources • https://elphick.lab.uconn.edu/intro-to-conservation-biology/ • https://www.wii.gov.in/ • https://old.amu.ac.in/emp/studym/100005960.pdf • https://www.slideshare.net/Bikramsingh106/conservation-biology-note-pdf • https://conbio.org/images/content_publications/ConservationBiologyforAll_reduced_size.pdf	

Learning Objectives

The learning objectives of this course are as follows:

- to give the students a fundamental understanding of the field of biotechnology.
- to provide a tool kit in the form of a number of techniques and processes developed over time to solve problems involving primarily human welfare with focus on health and medicine.
- to make the students aware of the scope of biotechnology which encompasses almost every field of science like engineering, research, commercialization and academics.
- to empower the students to face research and industrial outlets by nurturing independent thinking, initiating scientific enquiry and developing their entrepreneurship skills.
- to equip the students with basic understanding of the tools and techniques of biotechnology which are a must for anyone interested in pursuing a career in biotechnology.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of the basic principles and applications of biotechnology.
- appreciate the basic techniques used in genetic manipulation helping them continue with higher studies in this field.
- acquire knowledge of the basic principles, preparations and handling required for animal cell culture.
- have an in-depth understanding of the principles underlying the design of fermenter and fermentation process and its immense use in the industry.
- enable students to design small experiments for successful implementation of the ideas and develop solutions to solve problems related to biotechnology keeping in mind safety factor for environment and society.

- apply knowledge and skills gained in the course to develop new diagnostic kits and to innovate new technologies further in their career.
- enhance their understanding of the various aspects and applications of biotechnology as well as the importance of bio-safety and ethical issues related to it.

Course Title:	Animal Biotechnology	Course Code: 24MZO9106T
Total Lecture hour 60		
Unit I	Introduction and Techniques in Gene Manipulation : Concept and Scope of Biotechnology. Outline process of genetic engineering and recombinant DNA technology, Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids (lambda & M13). Shuttle and Expression Vectors. Genomic and cDNA libraries. Transformation techniques: Electroporation and Calcium Chloride method.	15
Unit II	Fermentation: Different types of Fermentation: Submerged & Solid state; batch, Fed-batch and Continuous; Stirred tank, Air Lift, Downstream Processing: Filtration, centrifugation, extraction, chromatography (Only Principles: Adsorption, Ion exchange, gel filtration, hydrophobic, affinity and size exclusion and lyophilization.	15
Unit III	Transgenic Animal Technology: Production of transgenic animals: Retroviral method, DNA microinjection method, Nuclear Transplantation: Dolly and Polly.	15
Unit IV	rDNA Application in Health: Recombinant vaccines, gene therapy (<i>in-vivo and ex-vivo</i>). Production of recombinant Proteins: Monoclonal Antibodies, Insulin and growth hormones, Bio safety: Physical and Biological containment.	15
Reference Books:		
1	Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.	
2	R. Ian Freshney (2021) Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell.	
3	Brown, T.A. (1998). Gene Cloning and DNA Analysis: An Introduction. II Edition, Academic Press, California, USA.	
4	Mathur, J.P. and Barnes, D. (1998) Methods in Cell Biology: Animal Cell Culture Methods. Academic Press.	
5	Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition, Freeman and Co., N.Y., USA	
6	Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes-A Short Course. III Edition, Freeman and Co., N.Y., USA	

Learning Objectives

The learning objectives of this course are as follows:

- to provide an overview of the fundamental concepts of biostatistics.
- to apprise students to the various statistical methods and software tools for understanding data analysis in biological sciences.
- to familiarize students with basic training and develop skills required for analysis of experimental data in biological sciences.
- to encourage students to pursue higher studies or career in biostatistics as Data Analyst, Data Scientist, Software Developer, Machine Learning Analyst, Research Scientist, Academicians, etc.

Learning Outcomes

By studying this course, students will be able to

- better understand the basic concepts of Biostatistics and its various applications in different fields of biological sciences.
- acquire basic skills to set up hypothesis and design research studies.
- enable students to differentiate among various experimental designs and apply appropriate statistical tests.
- develop the skills to collect and represent data in tabular and graphical forms.

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- analyze data and interpret experimental results using calculator, spread sheets software and online/offline software tools.

Course Title:	Methods in Biostatistics	Course Code: 24MZO9107T
Total Lecture hour 60		Hours
Unit I	Introduction to Biostatistics and Statistical Data: Aim and scope; applications in biological sciences. Sampling methods; Primary and secondary data; Qualitative and quantitative data; Discrete and continuous data; Presentation of data- graphical representation of data.	15
Unit II	Descriptive Statistics: Concepts of statistical population and samples, parameter and statistics; Measures of Central tendency and Dispersion - Mean, Median and Mode (grouped and ungrouped data); Variance, Standard Deviation and Standard Error; Coefficient of Variance.	15
Unit III	Probability ,Distributions and Testing of Hypothesis: Normal, Binomial and Poisson; Skewness and Kurtosis. Testing of Hypothesis Null and Alternative hypotheses; Concepts of statistical errors - Type I and Type II errors; Confidence Intervals and Confidence levels.	15
Unit IV	Statistical tests: Chi Square tests; Z test, t Tests - paired and unpaired; F test (one way ANOVA). Correlation and Regression ,Correlation Coefficient; Linear regression analysis.	15
Reference Books:		
1	Daniel, W.W. and Cross, C.L. (2018) Biostatistics: Basic Concepts and Methodology for the Health Sciences 11 th Edition, John Wiley & Sons, Inc.	
2	Motulsky, H. (2016) Essential Biostatistics: A Non-mathematical Approach Oxford University Press	
3	Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson EducationInc and Dorling Kindersley Publishing Inc. USA	

Semester- II

Learning Objectives

- A basic understanding of how to pursue research.
- A basic understanding of how to learn mathematics.
- A basic understanding of set theory.
- A basic understanding of the software that supports the mathematical research.

Learning Outcomes

- After completion of this course, students will be able to Understand mathematics more efficiently and clearly.
- Understand how to write a basic mathematics article.
- Make students analyze a given fact or concept and how to reach a concept.
- Make students curious enough to read the most recent trends in mathematics.
- Understand the basic ideas of how to write an algorithm and related ideas.
- Understand the effective use of open-source software to write mathematical articles.

Course Title:	Research Methodology	Course Code: 24MZO9201T
Total Lecture hour 60		Hours
Unit I	Nature of Scientific Inquiry-Scientific Methods-Induction- Deduction-Hypothesis and Theory and their Interpretation- Nature and Scope of Social Research for Multi-Disciplinary Inter-Disciplinary Approach in Commerce.	15
Unit II	Planning of Research-Selection of a Problem for Research- Sample design-Census and Sample Surveys-Sampling Techniques-Sample size.	
	Research Design-Important Aspects of Research Design.	15

	Methods of Data Collection-Sources of data Use of secondary data-Methods of collecting primary data-Observation-Interviews- Questionnaires and Schedules.	
Unit III	Processing and Analysis of Data: Processing Operations – Types of Analysis-Presentation and Interpretation of Data- Editing, Classification and Tabulation-Interpretation. Preparation of a Report-Types of Report-Research Report- Format-Principles of Writing Reports-Documentation-Foonoters and Bibliography	15
Unit IV	Quantitative Tools-Measures of Central Tendency-Dispersion- Measures of Correlation-Simple and Multiple Correlation-testing of Hypothesis-Tests based on t-P, Z, and Chisquare-Time Series Analysis-Trend Measurement-Moving Averages	15
Reference Books:		
1	Srivastava, S. C.: Foundation of Social Research and Economics Techniques, Himalaya Publishing House, 1990.	
2	Sharma H.D. and Mukherji S. P.: Research Methods in Economics and Business, New York: The Macmillan Company, 1992.	
3	Gerber R. and Verdoom, P.J.: Research Methods in Economics and Business, New York, The Macmillan Company, 1992.	
4	Krishnaswami O.R.: Methodology of Research in Social Sciences, Himalaya Publishing House, 1993.	
5	Menden HYall and Varacity: Reinmuth J.E.: Statistics for Management and Economics (2 nd Edition), 1982.	
6	Courtis J.K. (ed.) Research and Methodology in Accounting & Financial Management, 1980.	

Course Title:	Cell and Molecular Biology	Course Code: 24MZO9202T
Total Lecture hour 60		Hours
Unit I	Membrane structure and function, Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structural organization and function of intracellular organelles Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	15
Unit II	Organization of genes and chromosomes, Operon, unique and repetitive DNA, Interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons), Cell division and cell cycle, Mitosis and Meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle	15
Unit III	DNA replication, repair and recombination, Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. RNA synthesis and processing, Transcription factors and site-specific recombination. complex, Transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport	15
Unit IV	Protein synthesis and processing, Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing	15
Reference Books:		

1	Karp, G. (2020) Cell and Molecular Biology: Concepts and Experiments. IX Edition. John Wiley and Sons. Inc.
2	Lodish et. al., (2021), Molecular Cell Biology, VII Edition W.H. Freeman and Company, New York, USA
3	Alberts et. al., (2022), Molecular Biology of the Cell Garland Science, Taylor & Francis Group, New York,


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	USA
4	Cooper G. M. and Robert E. Hausman R. E.(2013) The Cell: A Molecular Approach, VI Edition, ASM Press and Sinauer Associates
5	Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2017). The World of the Cell. IX Edition. Pearson Benjamin Cummings Publishing, San Francisco
6	Watson, J. D, Baker T.A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2024) Molecular Biology of the Gene. VIII edition. Cold Spring Harbour Lab. Press, Pearson Pub
7	Lewin's Krebs J,E et. al. . (2017). Gene XII. Jones and Bartlett

Learning Objectives

- Students will learn about the chemical properties of molecules, determine the ways in which they interact and react with each other and understand how body works at system level
- Students will learn about the physiology of organs of human

Learning outcomes

At completion of the course the student will be able to:

- Explain human anatomy and physiology: describe cellular levels of organization, and the basics of biochemistry and cell biology.
- Discuss system physiology and their control and regulation mechanisms.
- Explain and examine histological samples and basic laboratory practice in cell culture
- Discover the interaction between body systems and the outside environment for the exchange of materials, the capture of energy, the release of waste, and the overall maintenance of the internal systems that regulate the exchange.
- Will be able to undertake investigations and perform analyses that provide information about biochemistry and solve related problems.

Course Title:	Animal Physiology	Course Code: 24MZO9203T
Total Lecture hour 60		Hours
Unit I	Digestive System: Nature of food-stuff, Various types of digestive enzymes and their action in alimentary canal, Absorption and assimilation of food, Nervous and hormonal control of digestion, Energy balance. Circulatory System: Comparative anatomy of heart structure, Blood volume, blood volume regulation, Comparative anatomy of heart structure, Myogenic heart, ECG- its principle and significance, cardiac cycle, Heartbeat, blood pressure and blood groups.	15
Unit II	Respiratory System: Transport of O₂ and CO₂ gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Excretory System: Comparative physiology of excretion, Functional architecture of kidney and nephron, Nitrogenous and products, formation of urine and its hormonal control, Role of kidney in osmoregulation, urine concentration, Electrolyte balance, acid-base balance. Muscular Systems: Types and properties of muscles, Functional architecture of skeletal muscles, Biophysical and biochemical events during muscular contraction.	15
Unit III	Nervous System: Functional architecture of neurons, Origin and propagation of nerve impulse through axon, Action potential, synaptic transmission, Reflex action, Neurotransmitter.. Thermoregulation and cold tolerance: Heat balance and exchange, endotherms Vs ectotherm, Counter-current heat exchanger, Torpor, hibernation and aestivation, Adaptations to extreme climate, Comfort zone, body temperature- physical, chemical and neural regulation. Stress: Basic concepts of environmental stress and strain, Homeostasis, physiological response to body exercise, Meditation. Yoga and their effects	15
Unit IV	Sense Organs: Structural architecture and functioning of eyes and ears, Tactile response Endocrinology: Endocrine glands in vertebrates, Mechanism of hormone action, hormones and related diseases. Reproduction: Reproductive cycle, Reproductive processes (Implantation, Parturition and Lactation), Neuroendocrine regulators in insects and mammals, Pheromones.	15
Reference Books:		

1	Animal Physiology Mechanisms and Adaptation. R. Eckert (ed), 5th edition, W.H. Freeman and Company, New York
2	Biochemical Adaptation. P.W. Hochachka and G.N. Somero (eds), Princeton Univ. Press, Princeton, New Jersey.
3	Animal Physiology: Adaptation and Environment, K.S. SchiemdtNeilsen (ed), University Press, Cambridge, UK
4	A regulatory Systems Approach. Strand, F.L. Physiology: Macmillan Publishing Co., New York
5	Environmental and Metabolic Animal Physiology, C.L. Prosser (ed), Wiley-Liss Inc., New York
6	Environmental Physiology, P. Willmer, G. Stone, and I. Johnson (eds), Blackwell Publishing, Oxford, UK
7	Guyton and Hall Text book of Medical Physiology, Mario Vaz, Tony Raj(2016), Elsevier Health Sciences

Course Title:	Zoology Laboratory	Course Code: 24MZO9204P
A	1. Isolation of genomic DNA from bacteria (E.coli) and human blood 2. Quantification of DNA using spectrophotometric method, 3.Isolation of plasmid DNA from bacteria Transformation of bacteria using CaCl₂ heat shock method 3. Digestion of DNA using restriction endonucleases 6.Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis, 4. Construction of restriction map by single and double digestion, Designing DNA probe 5. Southern blot hybridization 6. Amplification of known DNA sequences by Polymerase Chain Reaction. 7. Study of Mitosis in Onion root tip 8. Study of Meiosis in testis of Grasshopper/Cockroach 9. Study of Polytene chromosome in salivary gland of chironomous/Drosophila larva. 10. Project related to topics covered in theory/ project report based on visit to labs/institutions/industry etc. 11. Preparation of tissue culture/medium 12. Separation of a mixture of Aminoacids by Paper/TLC	
B	1. Observe and compare the inherent rhythmicity of the different parts of the heart. 2. Determine the effects of application of parasympathetic or sympathetic agonists/ antagonists. 3. Assessing physical and chemical modifiers of heart rate in frog. 4. Determine the response of the heart to direct electrical stimulation vagal stimulation. 5. Qualitative analysis of carbohydrates 6. Qualitative analysis of polysaccharides 7. Qualitative analysis of proteins 8. Qualitative analysis of lipids 9. Total count of blood corpuscles 10. Differential count of WBCs 11. Estimation of blood clotting time 12. Estimation of protein and hemoglobin 13. Estimation of cholesterol and triglycerides 14. Analysis of pathological contents of urine 15. Estimation of glucose 16. Identification of adulterants 17. Any other practical depending on feasibility. 18. To examine the relative activity of enzymes in the fore, mid, and hindgut of a typical insect and to correlate the enzyme activity with gut regions.	

References:

1. Neilsen, K.S. Animal Physiology: Adaptation & Environment. IV Ed. Cambridge University Press, 1995.
2. Prakash, M & Arora, C.K. Encyclopedia of Animal Physiology. Anmol Publications, New Delhi, 1998.
3. Pestonjee, D.M. Stress and Copping. Sage Publications, London, 1999.
4. Poole, M.C., Pilkey Grant and Johnson.E.C. Biology in Action. Harcourt Brace, Canada, 1995.
5. Hoar, W.S. General and Comparative Animal Physiology. Prentice Hall Inc, New Delhi, 1983.

6. Guyton C. Arthur and Hall J.E. Textbook of Medical Physiology. W.B.Saunders C. London, 1996.
7. Randall David., Burggren. W and French, K. Animal Physiology. W.H. Freeman and Co.New York, 1997.
8. Physiology by Best & Taylor.
9. Neilsen, K.S. Animal Physiology: Adaptation and Environment. IV Ed. Cambridge University Press, 1995.
10. Prakash, M. and arora C.K. Encyclopedia of Animal Physiology, Anmol Publications New Delhi, 1998.
11. Ausbel FM, Brent R, Kingston RE, Moore DD, Sediman JG, Smith JA, Sruhi V (1989) Current Protocols in Molecular Biology, Greene Publishing and Wiley Interscience, NY
12. Sambrook Joseph and Russell DW (2012) Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, NY.

Learning Objectives

The learning objectives of this course are as follows:

- to understand the components and functions of immune system of the body.
- to learn how the immune system responds to various infections and foreign substances that adversely affect our body.
- to help comprehend the concept of hypersensitivity and vaccines.
- to acquaint the students on the role of immune system in prevention and altered response to diseases.

Learning Outcomes

By studying this course, students will be able to

- acquire knowledge of immunogenicity and antigenicity.
- better understand innate and acquired immunity.
- appreciate and analyze the various humoral and cellular components of the immune system.
- comprehend the role of immune system in health and disease.
- gain knowledge of autoimmunity, immunodeficiency and hypersensitivity.
- have an enhanced understanding of vaccine and vaccination.

Course Title:		Course Code: 24MZO9205T
Total Lecture hour 60		Hours
Unit I	Immune System and its components Instructional and clonal selection theory; Innate immunity: components and defensive barriers of innate immunity. Adaptive immune system: Components and attributes of acquired immunity, humoral and cell mediated immunity, active and passive immunity, primary and secondary immune response.	15
Unit II	Antigens, Immunogens and Antibodies Antigens and immunogens; antigenicity and immunogenicity; factors affecting immunogenicity; antigenic determinants (B- and T-cell epitopes); concepts of antigen recognition by B- and T-cells. Structure and function of different classes of antibodies.	15
Unit III	Antigen Processing and Presentation, Cytokines & Complement System Structure and functions of MHC (MHC I & MHC II); endogenous and exogenous pathways of antigen processing and presentation. Properties and functions of cytokines; Pathways of complement activation and its biological consequences.	15
Unit IV	Role of immune system in Prevention of Diseases Gell and Coomb's classification of hypersensitivity; autoimmunity; immune dysfunctions and immunodeficiency with suitable examples. Vaccines and their types.	15
Reference Books:		
1	Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006) Immunology, VI Edition, W.H. Freeman and Company	
2	Abbas, K. Abul and Lichtman H. Andrew (2003) Cellular and Molecular Immunology, V Edition, Saunders Publication.	

3	David, M., Jonathan, B., David, R. B. and Ivan, R. (2006) Immunology, VII Edition
4	Janeway's Immunobiology 9th Edition, by Kenneth Murphy, Casey Weaver, Garland Science
5	Kenneth Murphy, Casey Weaver (2016) Janeway's Immunobiology; 9th Edition, Garland Science
6	Punt, J., Stranford, S., Jones, P., Owen, J.A. (2018) Kuby Immunology, VIII Edition, WH Freeman and Company
7	Singh, I. K. and Sharma, P. [Eds.] (2022) An Interplay of Cellular and Molecular Components of Immunology. Taylor & Francis group, CRC Press.
8	Kaur, H., Toteja, R., and Makhija, S. (2021) Textbook of Immunology, I.K International Publishing House and Wiley India Ltd

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint the students about biology of class Insecta.
- to acquire knowledge of the morphology and physiology of Insects.
- to enable the students to see, appreciate and understand the diversity of insects.

Learning Outcomes

By studying this course, students will be able to:

- better appreciate the diversity of insects.
- better understand the physiology of Insects which has made them the most successful animals in terms of numbers and variety of species.
- get acquainted with the highly organized social life of insects.
- to make the students aware about the possible scope of the subject which includes research and applied aspects including entrepreneurial skills

Course Title:		Biology of Insecta	Course Code: 24MZ09206T
Total Lecture hour 60			Hours
Unit I	Introduction	General features of Insects and their diversity; Classification of insects up to orders.	15
Unit II	General Morphology of Insects	Head: Eyes, Types of antennae, Mouth parts w.r.t. feeding habits; Thorax: wings Typical structure of insect wing and its modifications, Types of Legs; Abdomen: Typical structure.	15
Unit III	Physiology of Insects	General aspects of the Integumentary (structure of integument and process of moulting), digestive, excretory, circulatory, respiratory, reproductive, and nervous system (using cockroach as the type representative); Metamorphosis: Types & hormonal control.	15
Unit IV	Insect behaviour and insect pests	Insect-Plant Interactions: Host-plant selection by phytophagous insects. Bionomics and control of any two phytophagous insect pests of fruits, vegetables, cash crops and stored grains.	15
Reference Books:			
1	Chapman, R. F. (1998) The Insects: Structure and Function. Cambridge University Press, UK.		
2	Richards, O. W., Davies, R. G. (1977) Imms' General Text Book of Entomology. Vol I & Vol II; Chapman & Hall, UK.		
3	Snodgrass, R. E. Principles of Insect Morphology. Cornell Univ. Press, USA.		
4	Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the Study of Insects. M Saunders College Publication, USA.		

Learning Objectives

The learning objectives of this course are as follows:

- To offer an insight about the climatic conditions that favours fish growth and reproduction.

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- to understand the importance of fish as a rich source of animal protein.
- To learn the basic concepts and knowledge of fish biology and its applications.
- to equip the student with a balanced and complete scientific understanding of fisheries.
- to enable students to learn more technical skills to generate entrepreneurial skills and suitable employment opportunities.
- to acquire knowledge of the pathogenic and pathological basis of fish diseases including infectious diseases caused by viruses, prokaryotes, protozoans, helminthes, vector borne and zoonotic diseases.
- To learn about nutritional deficiencies and lifestyle diseases, endocrine diseases and cancer.

Learning Outcomes

By studying this course, students will be able to:

- acquire basic knowledge of physiology and reproduction in fishes.
- analyse different kinds of water and identify/differentiate among various kinds of fishes.
- equip the students with the knowledge on the procedures for artificial and induced breeding which can be learnt by visiting any fish farm or demonstrated in research labs in college/Departments.
- have more knowledge of the in-land and marine Fisheries in India and to explore ways in which it can contribute to the Indian economy.
- know more about the different methods of fishing and fish preservation

Course Title:		Fish and Fisheries	Course Code: 24MZO92071
Total Lecture hour 60			Hours
Unit I	Introduction and Classification General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction. Brief introduction to transgenic fishes		15
Unit II	Morphology, Physiology and Behavior Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Gills and gas exchange; Swim Bladder: Type and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs, Schooling; Parental care; Migration		15
Unit III	Fisheries Inland Fisheries; Estuarine Fisheries, Marine Fisheries; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations.		15
Unit IV	Aquaculture Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation of compound diets for fish; Role of water quality in aquaculture; Post harvest handling techniques and Fishery by-products.		15
Reference Books:			
1	Pandey, K. and Shukla, J.P. (2013) Fish and Fisheries. Rastogi publication, India		
2	Chakrabarti, R. and Sharma, J. G. (2008). Aquahouse: New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.		
3	Norman, J.R. A History of Fishes. Hill and Wang Publishers. Khanna, S.S. and Singh, H.R. (2014) A text book of Fish Biology and Fisheries. Narendra, Publishing House		
4	Bone, Q. and Moore, R. (2008) Biology of Fishes. Talyor and Francis Group, CRC Press, U.K.		
5	Srivastava, C.B.L. (2008) Fish Biology. Narendra Publishing House		
6	Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan Publication Cooperation. India.		

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Semester III

Tools and Techniques

Course Objectives

- To provide foundational knowledge of modern tools and techniques used in biological and environmental sciences.
- To develop an understanding of microscopy and its applications in cell and tissue analysis.
- To train students in various separation and analytical techniques, including centrifugation, chromatography, and electrophoresis.
- To introduce spectroscopic and radiological methods for molecular and elemental analysis.
- To equip students with practical knowledge of histological and tissue culture techniques relevant to research and diagnostics.

Course outcomes:

Upon successful completion of this course, students will be able to:

- Describe and compare different types of microscopes and their applications in biological research.
- Demonstrate an understanding of sedimentation principles and separation techniques used in analytical biology.
- Apply various chromatographic and electrophoretic techniques for qualitative and quantitative analysis of biomolecules.
- Utilise spectrophotometric and radiometric instruments to analyse biological and chemical substances.
- Perform basic histological procedures and animal tissue culture techniques, including cell viability and proliferation assays.

Course Title:	Tools and Techniques	Course Code: 24MZO9301T
Total Lecture hours: 45		Hours
Unit I	Principles, construction and applications of Microscopy: Light Microscopy, Bright field and Dark field Microscopy, Phase contrast Microscopy, Fluorescence Microscopy, Electron Microscopy (TEM & SEM), Confocal and Atomic Force Microscopy, Micrometry.	11
Unit II	Separation Techniques: Centrifugation: Basic principles of sedimentation, Types of centrifuges, Analytical and preparative centrifugation, Differential and density gradient centrifugation Chromatography: Paper chromatography, Thin layer chromatography, Ion exchange chromatography, Gel permeation chromatography, Affinity chromatography, Gas chromatography, High-pressure liquid chromatography (HPLC) Electrophoresis: Paper electrophoresis, Polyacrylamide gel electrophoresis (PAGE) and SDS-PAGE, Agarose gel electrophoresis, Two-dimensional electrophoresis and isoelectric focusing, Pulse field electrophoresis, Capillary electrophoresis, Immunoelectrophoresis, Blotting techniques (Southern and Western), DNA sequencing, Polymerase Chain Reaction (PCR)	12
Unit III	Principles and applications of colourimetry and spectrophotometry; UV-VIS Spectrophotometer. Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR). Dosimetry, ionisation chamber, GM counter, Solid and liquid scintillation counters Radioisotopes- types, characteristics and uses, Autoradiography.	11
Unit IV	Histological techniques: Principles of tissue fixation, factors affecting tissue fixation, Chemical basis of fixation by Formaldehyde, Glutaraldehyde, Chromium salts, Mercury salts, Osmium salts, Alcohol and Acetone, Theory and practice of Microtomy, Staining of carbohydrates, proteins, lipids and nucleic acids. Animal tissue culture techniques: Design of animal tissue culture laboratory and essential instruments required in tissue culture. Sterilisation of materials to be used for tissue culture. Culture media, preparation and essential components. Types of tissue culture, organ and organotypic cultures. Primary culture and the establishment of cell lines. Characterisation of cell lines. Cell	11

	proliferation measurements and cell viability tests. Cryopreservation and retrieval of cells from frozen storage.
Reference and Reading Books:	
1. Principle and Techniques of Practical Biochemistry; Wilson & Keith. Cambridge publications. 2. Biotechniques: Theory and Practice; SVS Rana. Rasthogi publications, Meerut. 3. Principles and Practice of Animal Tissue Culture; Sudha Gangal. Universities Press, Hyderabad. 4. Physical Biochemistry; David Freifelder. Freeman publications 5. Instrumental Methods of Chemical Analysis. G.R Chatwal and S.K. Anand. Himalaya Publishing House 6. Theory and Practice of Histological Techniques. John D Bancroft and Marilyn Gamble. Churchill Livingstone Elsevier. 7. Culture of Animal Cells- A Manual of Basic Techniques and Specialised Applications. R. Ian Freshney. Wiley-Black Well.	

Evolution and Biology of Chordates

Course Objectives:

The course aims to provide an in-depth understanding of the evolutionary history and biological diversity of chordates, with an emphasis on the origin, adaptive radiations, and functional morphology of major vertebrate groups, including fishes, amphibians, reptiles, birds, and mammals. It integrates classical and modern evolutionary theories to explore the anatomical, physiological, and ecological adaptations across chordate lineages.

Course outcomes:

By the end of this course, students will be able to:

1. Explain the fundamental principles and theories of evolution, including Lamarckism, Darwinism, and Neo-Darwinism, and evaluate supporting evidence from comparative anatomy, embryology, and physiology.
2. Describe the mechanisms of variation, mutation, natural selection, and speciation, and analyse their roles in evolutionary processes.
3. Discuss the phylogeny and evolutionary adaptations of primitive and advanced fishes, amphibians, and reptiles.
4. Analyse the evolutionary origin and flight adaptations in birds, and assess structural modifications such as beak and feet variations.
5. Evaluate the origin and diversification of mammals, including the evolution of endothermy and viviparity.
6. Interpret structural and functional adaptations in chordates that contribute to their ecological success and evolutionary advancement.

Course Title:	Evolution and Biology of Chordates	Course Code: 24MZO9302T
Total Lecture hours: 45		Hours
Unit I	1. Concept of evolution (Lamarckism, Darwinism & Neo Darwinism). 2. Evidence of evolution (macro and micro) – From comparative anatomy, embryology and physiology. 3. Variations: including transgressive variation. Mutations. Genetic drift. Meiotic drive. Migration. Natural selection. 4. Species and Speciation – Phylogenetic and biological and other concepts of species, modes of speciation (Allopatric, sympatric, parapatric and peripatric)	12
Unit II	1. A general account of the Elasmobranchii, Holocephali, Dipnoi and Crosspterygii. 2. Adaptive radiation in bony fishes. 3. Origin, evolution and adaptive radiation of Amphibia. 4. Origin and evolution of Reptiles: Seymouria and Cotylosauria; Dinosaurs 5. Skull types in Reptiles. 6. Sense organs in reptiles, including vomeronasal organs.	12
Unit III	1. Origin and evolution of birds. 2. Origin of flight: Flight adaptations. 3. Flightless Birds. 4. Modifications of beak, feet and palate in birds.	11
Unit IV	1. Origin of mammals: Primitive mammals (Prototheria and Metatheria); Evolution of viviparity	10

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	- Evolution and significance of exothermy & endothermy. - General account on adaptive radiations in Eutherian mammals. - Stomach in ruminants; evolution of primates.	
Reference and Reading Books:		
- The Chordata, Alexander, R.M. Cambridge University Press, London. - Structure and Habit in vertebrate evolution - carter, G.S.Sedgwick and Jackson, London. - Analysis of Vertebrate Structure. Milton Hilderbrand. John Wiley and Sons., Inc, New York. - Vertebrate Body. Romer A.S. W.B. Saunders Co., Philadelphia. - Life of Vertebrate, Young. J.Z. The Oxford University Press. London. - Life of Mammals, Young. J.Z. The Oxford University Press. London. - Evolution of the Vertebrates, Colbert. E.H. John, Wiley and Sons Inc., New York. - Vertebrate Paleontology. Romer. A.S.University of Chicago Press, Chicago. - Chordata Structure and Function. Waterman. A.J.Macmillan Co. New York. - Vertebrate Evolution. Joysey.K.A. and T.S.Kemp. Oliver and Boyd. Edinburgh. - The Phylogeny of Vertebrate. Lovtrup.S.John Wiley and Sons. London - The Biology of the Amphibia. Kingsley Noble G.Dover Publications. New York - Avian Biology (in several volumes), Farner, D. S. and King, J. R., Academic Press, New York, 1971. - Analysis of Vertebrate Structure, Hildebrand, M. 4th edition, John Wiley & Sons, Inc., New York, 1995. - Vertebrate Life, McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Macmillan Publishing Co., Inc., New York, 1979. - Text Book of Zoology, Parker, T. S. and Haswell, W. A., ELBS, 1978. Weichert CK and Presch. W. Elements of chordate Anatomy 4th Ed. Mc Growhall Co. New Delhi. - Mammalogy: Adaptation, Diversity, Ecology. 3rd Edition, George A Feldhamer Et, Johns Hopkins, 2007. - Vertebrates: Comparative Anatomy, Function, Evolution, 7th Edition, Kardong, Mc Graw Hill, 2014 - Encyclopedia of Evolution Vol .I and Vol. II By. Mark Pagel, Oxford University Press - Evolution Strickberger, M.W. Jones and Barlantt Publishers, Boston London - Evolution and Genetics. J.M. Oxford University Press, New York - Evolution and Genetics Merral, D.J. Holt, Rinchart and Winston, Inc. - Species Evolution – The role of chromosomal change . King, M. Cambridge University Press, Cambridge. - A primer of Population Genetics. Hart, D.L. Suinuaer Associate, Inc. Massachusetts. - Evolutionary Biology , Futuyamma, D.J. Suinuaer Associate, Inc. Publishers, Sunder land.		

Zoology Laboratory

Course Title:	Zoology Laboratory	Course Code: 24MZO9301P
	Experiments using a Fluorescence microscope and a Phase contrast Microscope. Preparation of samples using different centrifuges. Use of a Spectrophotometer for measuring the optical density of different biological samples. Separation of free sugars/amino acids from different samples by paper chromatography. Separation of neutral lipids/ amino acids by Thin Layer Chromatography. Separation of molecules by Ion exchange/ Gel permeation/ Affinity Chromatography (Demonstration). Study the working of (a) Gas Liquid Chromatography (b) HPLC (Demonstration). Separation of protein samples by PAGE/SDS-PAGE (Demonstration). Isolation of Genomic DNA from blood or any other sample. Study the working of PCR (Demonstration). Agarose gel electrophoresis of DNA. Study of DNA digestion using restriction enzymes and their separation. Visit to animal tissue culture laboratory (Report to be submitted). Viable cell counting with hemocytometer (Dye exclusion method). Fixing, dehydrating, embedding, section-cutting, staining and mounting of different tissues.	
	Anatomy - Cranial Nerves of <i>Wallago attu</i> or any other locally edible fish. - Display the Weberian ossicle in fish. - Tubular air sac of <i>Heteropneustus fossilis</i>, arboracenta organ of <i>Clarius</i>, labyrinthine. - organs of <i>Anabas</i>, a suprabranchial cavity in <i>Channa</i>.	

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	Museum specimens • Lower Chordates: Salpa- asexual and Sexual stages, Doliolum- oozoid, Botryllus, Herdmania and Amphioxus, Petromyzon, Myxine. • Pisces: Rhinobatus, Pristis, Trygon, Chimaera, Polydon, Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Notopterus, Exocoetus, Echeineis, Pleuronectes, Clarias, Mestacembelus, Diodon, Tetradon, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, Labeo, Ophiocephalus, Harpodon (Bombay Duck). • Amphibia: Ichthyophis, Necturus, Proteus, Ambystoma, Axolotl larva, Salamander, Siren, Alytes, Pipa, Bufo, Hyla, Rhacophorus, Rana. • Reptilia: Testudo, Chelone, Spheonodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus, Chameleon, Cobra, Hydrophis, Rattlesnake, Viper, Pit Viper, Krait, Eryx, Gavialis. • Aves: Archaeopteryx, Taylor Bird, Indian Koel, Jungle fowl, Pavo, Columba, Psittacula, Wood Pecker, Bubo (Horned), Flamingo. • Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat, Mongoose, Hystrix, Otter. Microscopic Slides • Lower Chordates: Herdmania -tadpole larva, Amphioxus -T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete-larva whole mount. • Pisces: Placoid scale, Cycloid scale, Ctenoid scale. • Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary, spinal cord, bone. • Reptilia: V S skin of lizard. • Aves: V S skin of bird, contour feather, down feather. • Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney, testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord. Comparative Osteology • Comparative account of axial and appendicular skeletons of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated). • Skull of Reptiles (Anapsida and Diapsida). • Palate in Birds. • Skull and lower jaw of a carnivore mammal & herbivore mammal. Note: With reference of whole mounts and museum specimens the animal types may be substituted with diagrams/photographs/models etc.
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Scheme of Practical Examination and Distribution of Marks for 24MZO9301P

Max. Marks: 100

Time: 6 hrs

1	Exercise 1 (DSC 1)	12 Marks
2	Exercise 2(DSC 1)	11 Marks
3	Exercise 3 (DSC 2)	12 Marks
4	Exercise 4 (DSC 2)	11 Marks
4	Spotting (8 x 3)	24 Marks
5	Seminar	10 Marks
6	Viva Voce	10 Marks
7	Class Record	10Marks

Concepts and Approaches to Ecosystem

Course Objectives:

1. To provide foundational knowledge of environmental biology and the interrelation between Earth systems and life.
2. To understand the physiological and ecological adaptations of organisms to varied environmental conditions.
3. To explore the structure, function, and diversity of terrestrial and aquatic ecosystems.
4. To analyse abiotic and biotic components and their interrelationships in different ecological settings.
5. To develop an ecological perspective necessary for ecosystem conservation and sustainable environmental management.

Course outcomes:

1. After completing this course, students will be able to:
2. Explain the fundamental principles and scope of environmental biology.
3. Identify and describe the structure and function of major Earth systems—lithosphere, hydrosphere, atmosphere, and biosphere.
4. Evaluate physiological adaptations of organisms in extreme environments (e.g., desert, alpine, aquatic).
5. Compare and contrast terrestrial ecosystems like forests, deserts, taiga, tundra, and grasslands.
6. Analyse aquatic ecosystems, including freshwater, marine, and estuarine systems with an understanding of species adaptations and zonation.

Course Title:	Concepts and Approaches to Ecosystem	Course Code: 24MZO9303T
Total Lecture hours: 60		Hours
Unit I	1. Concepts and Scope: Environmental Biology, Earth, man and environment. 2. The Earth Systems and Biosphere: Matter is conserved in various geospheres—lithosphere, hydrosphere, atmosphere, and biosphere. Climate of India. 3. Impact of environment at cellular level: Cellular interaction with the environment with special reference to pH, light, temperature and salinity.	15
Unit II	1. Environmental Physiology: Ecophysiological adaptations with special reference to desert, high altitude, lotic, marine environment, Hibernation and aestivation. Poikilo-therms and Homeotherms. Response to temperature and pressure. Thermal properties of water and survival limits, Acclimatisation.	15
Unit III	A detailed study of different ecosystems: The Study will include Abiotic and biotic components and their interrelationships, as well as animal productivity and adaptations. (I) Terrestrial ecosystems: Grasslands, including grazing lands. (II) Forests: Characteristics of alpine, temperate and tropical forests. Stratification. High altitude with special reference to Himalayan Ecology. (III) Deserts: Types and ecological attributes of desert biota. (IV) Taiga: Extent and ecological peculiarities. (V) Tundra: Extent and ecological peculiarities.	15
Unit IV	Aquatic Ecosystems: (i) Fresh water: Lakes include salt lakes, ponds, streams, springs, rivers, and marshes. (ii) Marine ecosystem: Zonation, fauna. (iii) Estuarine: Ecological peculiarities, adaptations, including impact on fauna.	15
Reference and Reading Books:		
1. Sharma, P.D. – Ecology and Environment, Rastogi Publications. 2. Kormondy, E.J. – Concepts of Ecology, Prentice-Hall India. 3. Singh, J.S., Singh, S.P., & Gupta, S.R. – Ecology, Environment and Resource Conservation, Anamaya Publishers. 4. Agarwal, K.C. – Environmental Biology, Nidhi Publishers. 5. Chopra, G.L. – Ecology and Environmental Biology, Pradeep Publications. 6. Bahuguna, V.K. – Forests in India: Environmental and Ecosystem Approaches, Indus Publishing. 7. MoEFCC Reports – on ecosystems, biodiversity, and Indian ecological zones. 8. Odum, E.P. & Barrett, G.W. – Fundamentals of Ecology, Brooks/Cole. 9. Molles, M.C. – Ecology: Concepts and Applications, McGraw-Hill. 10. Smith, R.L. & Smith, T.M. – Elements of Ecology, Pearson Education. 11. Begon, M., Townsend, C.R., & Harper, J.L. – Ecology: From Individuals to Ecosystems, Wiley-Blackwell. 12. Chapin, F.S., Matson, P.A., & Vitousek, P.M. – Principles of Terrestrial Ecosystem Ecology, Springer. 13. Likens, G.E. – Biogeochemistry of a Forested Ecosystem, Springer. 14. Wetzel, R.G. – Limnology: Lake and River Ecosystems, Academic Press.		

Environmental Education, Management and Regulations**Course Objectives:**

1. To develop a foundational understanding of the human-environment relationship and the importance of sustainable resource use.
2. To introduce the goals, objectives, principles, and strategies of environmental education.

global levels.

3. To explore major national and international environmental institutions, laws, and agreements.
4. To analyse India's environmental policies, legislation, and prominent grassroots movements.
5. To familiarise students with regulatory organisations and conventions focused on conservation and environmental protection.

Course outcomes:

Upon successful completion of the course, students will be able to:

1. Explain the core concepts and guiding principles of environmental education.
2. Identify and evaluate environmental problems and propose sustainable solutions.
3. Discuss major Indian and international environmental institutions and regulatory bodies.
4. Interpret and apply key environmental laws and acts relevant to pollution control and biodiversity conservation.
5. Assess the role of environmental movements and global treaties in shaping environmental governance and public awareness.

Course Title:	Environmental Education, Management and Regulations	Course Code: 24MZO9304T
Total Lecture hours: 60		Hours
Unit I	Environmental education: 1. Knowledge about the environment, knowledge about humanity environment relationship. 2. Knowledge about the Environment and population growth, knowledge about the solution and prevention of environmental problems, and rational use of resources. 3. Environmental education- goals, objectives, guiding principles. 4. Strategies for environmental education- Authorisation, Curriculum renewal, teacher's training renewal, teaching methods, evaluation. 5. Models for the future environmental education system.	15
Unit II	Environmental institutions and international cooperation: 1. Environmental Institutions, International Union for Conservation of Nature and Natural Resources (IUCN), World Wildlife Fund (WWF), US Environmental Protection Agency (EPA). 2. Global Environmental Agreements, Institutions of climate change, Indian Environmental Institutions, Central Pollution Control Board (CPCB). 3. Environmental Policies in India, Environmental Laws/Acts, National Environmental Tribunal Bill, 1992. 4. Environmental movements in India- The Chipko movement, Silent Valley movement, Appiko movement, Narmada Bachao Andolan, Teri Dam Conflict.	15
Unit III	Environmental laws: 1. Environmental Legislation status in India. 2. The Water (Prevention and Control of Pollution) Act, 1974. 3. The Air (Prevention and Control of Pollution) Act, 1981. 4. The Environment (Protection) Act, 1986. 5. The Biological Diversity Act, 2002. 6. The Wildlife (Protection) Act, 1972. 7. Bio-Medical Waste (Management and Handling) Rules, 1998.	15
Unit IV	National and international regulatory organisations: 1. MoEF (Ministry of Environment and Forests), ZSI (Zoology Survey of India) WII (Wildlife Institute of India), Bombay Natural History Society (BNHS). 2. Zoo Authority of India (ZAI), Salim Ali Centre for Ornithology & Natural History (SACONH), Indira Gandhi Conservation and Monitoring Centre (IGCMC), National Biodiversity Authority (NBA), Animal Welfare Board of India (AWBI), Centre for Environment Education (CEE). 3. WWF (World Wildlife Fund), UNEP (United Nations Environment Programme), CITES (Convention on International Trade of Endangered Species). 4. World Heritage and Biodiversity Convention, UNESCO (United Nations Educational, Scientific and Cultural Organisation). Ramsar (Wetland) sites in India and the Ramsar Convention.	15
Reference and Reading Books:		


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1. Sharma, P.D. – Ecology and Environment, Rastogi Publications.
2. Rajagopalan, R. – Environmental Studies: From Crisis to Cure, Oxford University Press.
3. Agarwal, K.C. – Environmental Biology, Nidhi Publishers.
4. Gupta, P.K. – Environmental Management, Agrobios (India).
5. Sengupta, R. – Ecology and Environmental Science, University Science Press.
6. Bharucha, E. – Textbook of Environmental Studies for Undergraduate Courses, University Grants Commission.
7. MoEFCC Publications – Acts, Policies, and Reports related to Environment (available at moef.gov.in).
8. Centre for Environment Education (CEE) – Educational materials on environmental awareness and sustainability.
9. Cunningham, W.P. & Cunningham, M.A. – Principles of Environmental Science, McGraw-Hill.
10. Botkin, D.B. & Keller, E.A. – Environmental Science: Earth as a Living Planet, Wiley.
11. Chiras, D.D. – Environmental Science: Creating a Sustainable Future, Jones & Bartlett.
12. Miller, G.T. & Spoolman, S. – Living in the Environment, Cengage Learning.
13. Barrow, C.J. – Environmental Management: Principles and Practice, Routledge.
14. UNEP & UNESCO Reports – on Environmental Education, Sustainable Development Goals (SDGs), and Biodiversity Conventions.
15. WHO Publications – on environmental health, pollution, and sustainable living.

Environmental Toxicology and Environmental Health

Course Objectives

1. To provide foundational knowledge of environmental toxicology and its scope.
2. To understand the principles of toxicity testing and the behaviour of toxins in the environment.
3. To explore sources of environmental pollution, monitoring methods, and strategies for waste management.
4. To examine the health impacts of toxicants, including pesticides, heavy metals, solvents, and food additives.
5. To introduce methodologies for environmental impact and risk assessment.

Course outcomes:

Upon successful completion, students will be able to:

1. Explain key concepts and types of environmental toxicity and dose-response relationships.
2. Conduct and interpret basic toxicity tests and bioassays.
3. Assess pollutant effects on health and the environment and apply pollution control methods.
4. Identify major toxicants and understand their health impacts in public and occupational settings.
5. Apply EIA and risk assessment techniques in environmental management.

Course Title:	Environmental Toxicology and Environmental Health	Course Code: 24MZO9305T
Total Lecture hours: 60		Hours
Unit I	ENVIRONMENTAL TOXICOLOGY 1. Definition, scope and history of Toxicology, Fundamental of Ecotoxicology, Acute, Sub-acute and Chronic toxicity, Doses, Dose-Response relationships, LC50, LD50, Effective Concentration (EC), Maximum Acceptable Toxicant Concentration (MATC), Application Factor (AF), Cumulative toxicity. 2. Toxicity Testing: Definition, purpose, criteria for selection of test organism, methodology, estimation of LC50 & LD50, Limitation and importance of bioassay, teratogenicity, carcinogenicity and mutagenicity. Good Laboratory Practices (GLP). 3. Movement, distribution and fate of toxins in the environment, Bioconcentration, Bioaccumulation, Processes of bioaccumulation, Biomagnification, factors affecting biomagnification. 4. Translocation of xenobiotics: absorption, distribution, biotransformation and excretion. 5. Detoxification mechanisms: Phase I and Phase II reactions.	15


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Unit II	Environmental pollution and management: 1. Sources and classification of pollutants, primary and secondary pollutants, Effects of pollutants on human health, animal, vegetation, materials and structures. 2. Air quality standards and monitoring methods; Water quality standard for potability-Pollution parameters, BOD, COD, Coliform bacteria; Soil quality parameters and test methods. National and International standards of noise, Assessment and measurement of sound; Safety standards of radiation. 3. Liquid waste management: Treatment of water for potable purposes (mixing, sedimentation, coagulation, filtration and disinfection), Primary and secondary treatment. Sludge disposal. Biological treatment: Kinetics of Biological growth, activated sludge treatment, trickling filters, anaerobic digestion, combined aerobic and anaerobic treatment process, aerobic process. Advanced waste water treatment- removal of dissolved organic and inorganic precipitation, iron exchange, reverse osmosis, electro dialysis, adsorption and oxidation. 4. Water pollution treatment using constructed wetlands, Bioremediation. 5. Solid Waste Management: Municipal solid wastes (MSW) quantities and characteristics, waste collection and transport, waste processing and resources recovery and recycling. Aerobic and anaerobic systems composting, vermicomposting; Bio-digesters (Biogas plants); incineration, pyrolysis, plasma pyrolysis; sanitary landfills and open dumping yards. 6. Management of plastic and e-waste. Treatment processes for unsegregated waste, fixation of hazardous solid waste before disposal, and hazardous waste in landfills. Reduction, Recycling and Reuse (3Rs) of waste. Waste minimisation techniques. Hazardous Waste (Management and Handling) Rules 1989, the Manufacture, Storage and Import of Hazardous Chemicals Rules 1989 - Biomedical Waste (Management and Handling) Rules 1998- Plastic Act 1999. Extended producer responsibility.	15
Unit III	Toxicants of public health and occupational health: 1. Toxicity of Pesticides: Organochlorines, Organophosphates, Carbamates and Pyrethroids. 2. Toxicity of heavy metals and metalloids: Arsenic, Mercury, Lead, Aluminium, Cadmium, Chromium and Copper. 3. Toxicity of solvents: (a). Aliphatic solvents-Carbon tetrachloride, Chloroform, Trichloroethylene, Tetrachloroethylene. (b). Aromatic hydrocarbons-Benzene, Toluene, Xylene, Styrene. (c). Alcohols-Methanol, Ethanol. 4. Food additives: Antioxidants, Emulsifiers, Flavouring agents, Colours and Preservatives, Artificial sweetening agents. 5. Occupational hazards and diseases: Physical hazards (Heat and cold, light, noise, vibration, ultraviolet radiation, ionizing radiation), Chemical hazards (Mustard gas, Nerve agents, Lewisite, Phosgene oxime, Cyanide), Biological hazards (Anthrax, Leptospirosis, Psittacosis, Botulism, Brucellosis, Cholera, Gas Gangrene, Ebola hemorrhage Fever, Melioidosis, Q fever, Rift Valley fever, Ricin, Saxitoxin, Mycotoxins, Tularemia). Psychosocial hazards and diseases. 6. Pneumoconiosis: Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmer's lung, Occupational cancers, Radiation hazards.	15
Unit IV	Environmental impact and risk assessment: 1. Definition, Scope, Characteristics, Objectives and Components. 2. EIA process and methodology; Procedure for obtaining EIA clearance; Preparation of EIA document; Major limitations of EIA; EIA Case Studies. 3. Prediction and assessment of impacts on earth resources. 4. Risk Assessment: Hazard identification, classification, toxicity assessment, exposure assessment, risk characterisation, public perception of risk and risk communication.	15
Reference and Reading Books: 1. Awasthi, I.C. – <i>Environmental Pollution and Toxicology</i>, Pointer Publishers. 2. Trivedi, R.K. & Goel, P.K. – <i>Introduction to Air Pollution</i>, Techno Science Publications. 3. Banerjee, G.C. – <i>Environmental Toxicology</i>, Oxford & IBH Publishing. 4. Dara, S.S. – <i>A Textbook of Environmental Chemistry and Pollution Control</i>, S. Chand Publishing. 5. Sharma, B.K. & Kaur, H. – <i>Environmental Chemistry</i>, Goel Publishing House. 6. Pandey, G.N. – <i>Environmental Management</i>, Vikas Publishing House. 7. Agarwal, S.K. – <i>Pollution Management</i>, APH Publishing.		

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8. Gupta, P.K. – *Elements of Toxicology*, Rastogi Publications.
9. Kudesia, V.P. – *Air Pollution*, Pragati Prakashan.
10. ICMR & NIOH Publications – Reports on occupational health, heavy metals, and pesticides in India.
11. MoEFCC Reports and Manuals – Environmental Impact Assessment, Risk Assessment Frameworks.
12. CPCB Technical Manuals – Water, air, noise, and solid waste standards and protocols.
13. Casarett & Doull's Toxicology: The Basic Science of Poisons (Klaassen, C.D.) – McGraw-Hill Education.
14. Environmental Toxicology (Moriarty, F.) – Academic Press.
15. Principles of Ecotoxicology (Newman, M.C. & Unger, M.A.) – CRC Press.
16. Introduction to Environmental Toxicology (Landis, W.G. & Yu, M.H.) – CRC Press.
17. Environmental Health: From Global to Local (Frumkin, H.) – Jossey-Bass.
18. Toxicology (Golan, D.E. et al.) – Lippincott Williams & Wilkins.
19. A Textbook of Modern Toxicology (Hodgson, E.) – Wiley.
20. Ecotoxicology: A Comprehensive Treatment (Walker, C.H. et al.) – CRC Press.
21. Environmental and Occupational Medicine (Rosenstock, L. et al.) – Lippincott Williams & Wilkins.
22. Environmental Toxicology and Chemistry (Raiswell, R. et al.) – Wiley-Interscience.

Environmental Biology Laboratory

Course Objectives:

1. To develop practical skills for analysing environmental samples (water, soil, air, and biological specimens).
2. To train students in physico-chemical and microbiological analysis techniques for water and soil quality assessment.
3. To promote field-based ecological and biodiversity assessment methods in diverse ecosystems.
4. To provide hands-on experience in ecotoxicological studies, including histopathology and LC₅₀ determination.
5. To encourage student engagement in real-world environmental issues through case studies, institutional visits, and field projects.

Course outcomes:

Upon successful completion of this practical course, students will be able to:

1. Perform water and soil quality assessments using standard physicochemical and microbial techniques.
2. Evaluate pollution levels in aquatic ecosystems through BOD, COD, and toxicity assays.
3. Identify and study ecological parameters like biodiversity indices, species richness, and population density through field surveys.
4. Analyse histopathological effects of pollutants on animal tissues using microscopy.
5. Conduct case studies on environmental disasters and conservation efforts, and report findings with scientific rigour.
6. Engage in field-based studies and contribute to sustainable environmental practices like rainwater harvesting documentation.

Course Title:	Environmental Biology Laboratory	Course Code: 24MZO9302P
	- Mark the location of different biomes on the world map and write their characteristics. - Mark important Sanctuaries and National Parks of Rajasthan on the map and write details of any two. - Mark the major Ecozones of India on the map of India. Visit a desert/grassland/rain forest and submit a write-up.	
	- Water Quality Analysis: Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate, Silica and fluoride. Determination of total suspended and dissolved solids/salts (TSS &TDS). - Toxicity Analysis of Water: For Chlorine, H₂S, Ammonia, Copper and Chromium. - Estimation of BOD and COD of polluted water. - Determination of LC₅₀ for fish (pesticide) using Probit analysis (use of appropriate software is suggested). - Study of Histo-pathological changes in any two of the tissues (Liver/ Kidney/ Gonad) using pesticide/heavy metal/nanoparticle.	
	- Bacteriological quality testing of water and wastewater: (a). Presumptive coliform test (MPN Index), (b). Confirmatory coliform test, completed test. - Study of waterborne diseases.	

	- Determination of soil pH from at least three different locations and correlate it with the soil type. - Analysis of soil composition: Chloride, Calcium, Magnesium, Potassium and Phosphorus. - Estimation of sulphates in soil. - Estimation of fluoride in soil.
	- Case studies on oil pollution and nuclear reactor disasters (At least one each). - Study the ecology of the Aravali Hills around the Shekhawati region. - Find out the density of Monkeys/any domestic animal in an area using the Line transect method.
	Study of biodiversity in Forest/Grassland and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices. (This can be done as part of the three / four day field study compulsory for this elective).
	Visit to Institutions engaged in environment /conservation research; a sanctuary/national park. Report the study conducted and submit a write-up/ print out giving the dates, methodology, results and references. Include photographs of the activity.
	Project work: To locate and describe water harvesting systems like tanka/bavri in and around the Shekhawati region, and physicochemical and microbiological analysis of their water. (This can be done as part of the three/four day field study compulsory for this elective).

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

Scheme of Practical Examination and Distribution of Marks for 24MZO9302P

Max Marks: 100

Time: 6 hours

1	Exercise 1	10 Marks
2	Exercise 2	10 Marks
3	Exercise 3	10 Marks
4	Exercise 4	10 Marks
5	Spotting (8 x 3)	24 Marks
6	Seminar	10 Marks
7	Viva Voce	10 Marks
8	Class Record & Report	16Marks

Phylogeny, Taxonomy and Evolution of Insects

Course Objectives

- To develop foundational and advanced knowledge of insect taxonomy and phylogeny.
- To introduce students to methods of collection, preservation, and scientific study of insects.
- To impart understanding of the classification and evolutionary history of primitive and advanced insect groups.
- To explore the origin and adaptive success of insects through fossil records and evolutionary theories.
- To provide detailed taxonomic insight into economically and ecologically important insect orders.
- To introduce molecular tools such as DNA base reading and their applications in entomology.

Course outcomes:

- By the end of this course, students will be able to:
- Explain the methods of insect collection, preservation, and identification using taxonomic keys.
- Distinguish between different groups of primitive insects and describe their evolutionary significance.
- Analyse the origin, fossil records, and adaptive strategies that led to the success of insects.
- Classify major insect orders and selected families based on morphological and anatomical features.
- Compare the characteristics of Trilobita, Chelicerata, and Mandibulata in an evolutionary context.

context.

7. Apply basic molecular techniques such as DNA base reading in insect taxonomy and systematics.

Course Title:	Phylogeny, Taxonomy and Evolution of Insects	Course Code: 24MZO9306T
Total Lecture hour: 60		Hours
Unit I	1. Collection, preservation and methods of study of insects. 2. Basis of insect classification, use of taxonomic keys in insect identification. 3. Phylogeny of Arthropoda and Hexapoda.	15
Unit II	1. Introduction to primitive insects. 2. Endognathus hexapods: Protura, Collembola and Dipleura. 3. Apterygota: Microcoryphia and Thysanura.	15
Unit III	1. Origin and evolution of insects with special reference to fossil insects. 2. Causes of success of insects. 3. Theories on the evolution of insects.	15
Unit IV	1. Detailed classification of important and selected super families and families of insects of the following orders- Orthoptera, Isoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera. 2. Characteristics of <i>Trilobita chelicerata</i> and Mandibulata. 3. Elementary idea of DNA base reading and its application in entomology.	15
Reference and Reading Books:		
1. Atwal, A. S. – Agricultural Pests of India and South East Asia, Kalyani Publishers, 1986. 2. Chapman, A. D. – The Insects: Structure and Function, 4th Ed., ELBS, 1998. 3. Klowden, M. J. – Physiological Systems in Insects, 2002. 4. McGavin, G. C. – Essential Entomology, Oxford University Press, 2001. 5. Snodgrass, R. E. – Principles of Insect Morphology. 6. Wigglesworth, V. B. – The Principles of Insect Physiology. 7. Triplehorn, C. A., & Johnson, N. F. – Borror and DeLong's Introduction to the Study of Insects, Thomson Brooks/Cole. 8. Nation, J. L. Sr. – Insect Physiology and Biochemistry, 3rd Ed., Taylor & Francis, 2016. 9. Prakash, A., & Rao, J. – Botanical Pesticides in Agriculture, CRC Press, 2014. 10. Chauhan, S. K., & Abraham, A. – Forensic Entomology, Black, 2015. 11. Wylie, R. F. – Insect Pests in Tropical Forestry, 2nd Ed., CABI Publishing, 2012. 12. Mullen, G. R., & Durden, L. A. – Medical and Veterinary Entomology, 2nd Ed., Bio-Green, 2013. 13. Kavane, R. K., & Sathe, T. V. – Wild Silk Technology, Daya Publishing House, 2011.		

Morphology and Physiology of Insects

Course Objectives

1. To provide comprehensive knowledge of insect body structure, including external and internal anatomy.
2. To understand the morphology and physiology of major organ systems in insects.
3. To explore the adaptations in respiratory, excretory, and digestive systems across insect taxa.
4. To study insect sensory organs and their roles in communication and environmental perception.
5. To examine the structure and function of insect reproductive and neuro-endocrine systems.
6. To understand the hormonal regulation of development, reproduction, and metamorphosis in insects.

Course Outcomes

After completing this course, students will be able to:

1. Explain the structural organization of the insect body, including head, thorax, and appendages.
2. Describe the functioning and adaptation of various physiological systems: digestive, circulatory, respiratory, and excretory.
3. Identify and interpret the sensory and nervous systems of insects and their ecological significance.
4. Illustrate the muscular system and reproductive structures of insects and explain their physiological functions.
5. Understand the endocrine mechanisms involved in insect growth, reproduction, and metamorphosis.
6. Apply knowledge of insect physiology to entomological research and pest management.


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Course Title:	Morphology and Physiology of Insects	Course Code: 24MZO9306T
Total Lecture hours: 60		Hours
Unit I	1. General organization of insect body: 2. Integument. 3. Head: Sutures and area of cranium, Dyanin law, tentorium, gnathal appendages, antennae 4. Thorax: Legs and their modifications, wings and wing coupling, wing bearing segment.	15
Unit II	1. Digestive system: Alimentary canal and its modifications (including filter chamber), Physiology of digestion. 2. Physiology of circulatory system. 3. Excretory system and its modifications (Cryptonephridial system). 4. Respiratory system and its modifications, adaptations for aquatic respiration.	15
Unit III	1. Nervous system and its modifications. 2. Sense organs: Mechanoreceptors, Chemoreceptors. 3. Auditory organs (tympanum), light producing organs, sound producing organs, visual organs (Compound eye and ocelli).	15
Unit IV	1. Muscular system and distribution of muscles. 2. Reproductive system. Morphology and physiology of male and female reproductive system, its associated ducts and glands and external genitalia, pheromones. 3. Morphology and physiology of neuro-endocrine system. 4. Endocrine control of development and metamorphosis.	15
Reference and Reading Books:		
1. Snodgrass, R. E. – Principles of Insect Morphology. 2. Wigglesworth, V. B. – The Principles of Insect Physiology. 3. Chapman, A. D. – The Insects: Structure and Function, ELBS. 4. Klowden, M. J. – Physiological Systems in Insects. 5. Nation, J. L. – Insect Physiology and Biochemistry, 3rd Ed., CRC Press. 6. Richards, O. W. & Davies, R. G. – Imm's General Textbook of Entomology. 7. McGavin, G. C. – Essential Entomology. 8. Triplehorn, C. A. & Johnson, N. F. – Borror and DeLong's Introduction to the Study of Insects.		

Course Objectives

1. To introduce the principles of insect embryology and metamorphosis.
2. To explain developmental stages, including larval and pupal forms.
3. To explore social behaviour and life cycles of selected insect groups like Isoptera, Hymenoptera, locusts, and aphids.
4. To understand the role of insects in disease transmission and the importance of vector control.
5. To study the role of global organisations in managing insect-borne diseases.
6. To provide applied knowledge about beneficial insects and their associated industries (silk, honey, and lac).

Course outcomes:

After completing this course, students will be able to:

1. Describe the structure of insect eggs and the process of embryonic and post-embryonic development.
2. Identify and compare different types of larvae, pupae, and metamorphosis in insects.
3. Analyze the social structure and polymorphic life cycles of insects like termites, bees, locusts, and aphids.
4. Evaluate the role of various insects in the transmission of diseases and describe their control measures.
5. Explain the contributions of organizations like WHO and UNICEF in vector management.
6. Apply knowledge of sericulture, apiculture, and lac culture to understand their industrial and economic importance.


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Course Title:	Development of Insects & Medical and Applied Entomology	Course Code: 24MZO9308T
Total Lecture hours: 60		Hours
Unit I	5. Embryology: Structure of egg, types, embryonic and post-embryonic development. 6. Types of larvae, pupae and metamorphosis (Ametabolous, hemimetabolous and holometabolous).	15
Unit II	1. Social life in Isoptera and Hymenoptera. 2. Life cycle of locusts (phase theory). 3. Life cycle of aphids (polymorphism). 4. Evolution of societies in insects.	15
Unit III	1. Pests of medical and veterinary importance; vectors of various diseases (protozoans, viral and bacterial). Their control and management. 2. Role of WHO and UNICEF in their management.	15
Unit IV	1. Beneficial insects. 2. Silk worm, honey bee and lac insect cultivation and industries related to them. Problems related to these industries.	15
Reference and Reading Books:		
1. Chapman, A. D. – The Insects: Structure and Function, ELBS. 2. Gullan, P. J. & Cranston, P. S. – The Insects: An Outline of Entomology. 3. Imms, A. D. – A General Textbook of Entomology. 4. Srivastava, K. P. – Textbook of Applied Entomology Vol I & II. 5. Wigglesworth, V. B. – The Principles of Insect Physiology. 6. Chauhan, S. K., & Abraham, A. – Forensic Entomology. 7. Mullen, G. R., & Durden, L. A. – Medical and Veterinary Entomology, 2nd Ed. 8. Nayar, K. K., Ananthakrishnan, T. N. & David, B. V. – General and Applied Entomology.		

Entomology Laboratory

Course Title:	Entomology Laboratory	Course Code: 24MZO9303P
	1. Anatomy: a) Cockroach: Alimentary canal, Endocrine complex, Nervous system., b) Grass hopper: Alimentary canal, Reproductive system, Nervous system, c) White grub: Nervous system 2. Permanent Mounting: a) Biting and chewing mouth parts (cockroach) b) Piercing and sucking mouth parts (mosquito) c) Siphoning mouth parts (Butterfly) d) Tympanum and spiracle of Grasshopper (<i>Poecilocerous pictus</i>) e) Antennae, wings and legs of mosquito, butterfly, grasshopper, cockroach f) Whole mounts of (lice, ants, termite, bedbug, mosquito) 3. Insect rearing: a) <i>Tribolium</i> b) <i>Rhizopertha</i> c) <i>Heliothis armigera</i> d) <i>Corcyra</i> e) <i>Callosobruchus sps</i> f) <i>Lesioderma serricornae</i> 4. Study of prepared slides: a) Whole mounts of insects b) Legs c) Mouth Parts d) Wings e) Antennae	


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	f) Histology of Insects
5.	Study of selected insects: a) Study of selected insects as museum specimens. b) Identification of selected insects and their identification with the help of taxonomic key.
6.	Microtomy
7.	Field trips for insect collection; Preservation of insects (eggs, larvae, pupae & adults)
8.	Spotting: a) Insect specimens with morphological adaptation b) Whole mounts of insects c) Their specialised body parts
d)	Histology slides

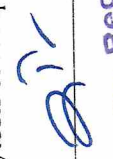
Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

Scheme of Practical Examination and Distribution of Marks for 24MZ09303P

Max Marks: 100

Time: 6 hours

1	Exercise 1	10 Marks
2	Exercise 2	10 Marks
3	Exercise 3	10 Marks
4	Exercise 4	10 Marks
5	Spotting (8 x 3)	24 Marks
6	Seminar	10 Marks
7	Viva Voce	10 Marks
8	Class Record & Report	16 Marks

Course Title:	Cellular Membrane Structure and Function	Course Code: 24MZ09309T
Total Lecture hour: 60		Hours
Unit I	Membrane Biology 1. Bio-membranes: Component of Biological Membrane: Lipids (glycerophospholipids, sphingophospholipids, glycolipids, sterols); Proteins (extrinsic, intrinsic –glycophorin, porin & fusion proteins) 2. Fluidity and mobility of membranes 3. Mechanism of diffusion; Facilitated diffusion. Osmosis, permeability constant, factors influencing permeability & Gibb's – Donnan effect. 4. Uniporter-catalyzed transport, difference between uniport-catalyzed transport and passive diffusion, GLUT- 1-5 transport & its kinetics. 5. Ion channels and membrane electric potential (Nernst equation). 6. Active transport - P-class ion pumps, F-class and V-class ion pumps, ABC superfamily. Plasma membrane Ca^{++} ATPase pump, Muscle Ca^{++} ATPase pump & Na^+/K^+ ATPase pump, Ionophores. 7. Co-transport by symporters and antiporters. 8. Transport across epithelia; Endocytosis: pinocytosis, phagocytosis & receptor mediated; Transcytosis. 9. Diseases: Cystic fibrosis & Type I Diabetes mellitus.	15
Unit II	Cell-Cell signalling: 1. Endocrine, paracrine and autocrine signaling.	15  Dy. Registrar Pandit Deendrakumar Shukla Shankar, Jabalpur

	2. Receptor Proteins: Cell surface receptors and intracellular receptors, toll receptors. 3. Second messenger System: cAMP & signal to transcription (CREB); IP₃ DAG and PIP₃ (PI-3 kinase, AKT & mTOR pathway). 4. Cell Surface receptors: G-protein coupled receptors (hormones etc.), ion channel receptors (voltage gated channel, ligand gated channel & signal gated channel), tyrosine kinase-linked receptors (general idea, EGF, erythropoietin & interferon) and receptors with intrinsic enzymatic activity. 5. MAP kinase, JAK/STAT and TGF-β / and NF-kB signalling.	
Unit III	Cytoskeleton: 1. Intermediate filament: Proteins, assembly, organization. 2. Microfilaments: (i) Actin: G-actin, F-actin, structural and functional polarity. (ii) Assembly, disassembly and organisation of actin filaments: Polymerization, actin-binding proteins (Formin, Arp2/3 complex, ADF/Cofilin, Profilin, CapZ etc.), actin bundling proteins, toxins affecting polymerization. 3. Actin filaments and plasma membrane: RBC cytoskeleton, platelet cytoskeleton & projecting fingers of membrane. 4. Myosin: Structure, mechanism of movements with actin & conformational changes in myosin during movement. 5. Microtubules: Structure, assembly of microtubules from organizing centre, dynamic organization, microtubule associated proteins (MAPs), microtubules associated structures (Centrosome duplication, kinetochore and force for poleward chromosome movement, Organization of spindle pole and orientation of assembly, astral microtubule and cytokinesis & microtubules and plant cell formation) and drugs disrupting microtubules. 6. Microtubules motor proteins: (i) Intracellular transport: Role of kinesin and dynein, microtubule tracks and intracellular membrane vesicles. (ii) Dyes and stains: Vital staining and Stains for visualization of cytoskeleton	15
Unit IV	Cell-cell adhesion and communication: 1. Cadherin mediated Ca²⁺ dependent homophilic cell-cell adhesion. 2. N-CAM's mediate Ca²⁺ independent homophilic cell-cell adhesion. 3. Cell junctions: Occluding junctions, anchoring junctions (adhesion belts, focal contacts, desmosomes & hemidesmosomes) & communicating junctions (gap junctions, chemical synapses & plasmodesmata). 4. Cell adhesion molecules as diagnostic tools in cancer. Cell matrix adhesion molecules: 1. Integrin-in cell matrix and cell-cell interaction. 2. Collagen-Basic structure and assembly. 3. Non-collagen components of extracellular matrix (elastin, glycosaminoglycans, cell Surface proteoglycans, fibronectin & laminin). 4. Role of selectin, integrin & Ig in extravasation.	15
Reference and Reading Books: 1. The Biochemistry of the Nucleic Acids. Adams RLP, Knowler JT and Leader DP. Chapman and Hall, London.1986. 2. Essential Cell Biology 4th edition. Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K and Walters P. Garland Science Publishing New York UISA ,2013. 3. Molecular Biology of the Cell. 5th edition. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. Garland Science.2007. 4. Molecular Biology of the Cell. 4th edition Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Garland Science .2002. 5. From Genes to Cells. Bolrover SR, Hyams JS, Jones S, Shephard EA and White HA. Wiley –Liss, New York.1997. 6. A Means to an End: The Biological Basis of Aging and Death. Clark WR. Oxford University Press, New York, Oxford.2002. 7. The Cell .A Molecular Approach.4th edition. Cooper GM and Hausman RE. ASM Press Washington, DC.2007.		

8.	Cell Adhesion and Cytoskeletal Molecules in Metastasis. Cross AE and Nagle RB. Vol XII. Springer Publications 2006.
9.	Molecular Cell Biology. 5 th edition W Darnell J. H Freeman and Company, New York, 2004.
10.	Cell and Molecular Biology. 8 th edition. De Robertis EDP and De Robertis Jr EMF Lippincot Williams & Wilkins 2006.
11.	Cell Adhesion Molecules in Cancer and Inflammation. Epenetos A and Pignatelli M. Harwood Academic Publishers, CRC Press 1995.
12.	Cancer Stem Cells. Farrar WL. Cambridge University Press. 2009.
13.	DNA Repair and Mutagenesis. Friedberg EC, Walker GC and Siede W. ASM Press, Washington DC 1995.
14.	BRS Cell Biology and Histology. 6 th edition (South Asian Edition), Gartener LP, Hiatt JL, Strum JM. Lippincott Williams & Wilkins, 2010.
15.	Molecular biotechnology. Principles and Applications of Recombinant DNA. Glick BR and Pasternak JJ. ASM Press Washington DC, 1998.
16.	Cell and Molecular Biology. Concepts and Experiments. 7 th edition. Karp G. John Wiley & Sons Inc., New York. 2013.
	Cell Biology. 6 th edition. Karp G. Hoboken, NJ: Wiley 2013.

Course Title:	Cellular Physiology and Regulatory Mechanism	Course Code: 24MZO9310T
Total Lecture hour: 60		Hours
Unit I	Cell cycle: Molecular Biology of Cell cycle: Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle. Regulation of Cell cycle progression: Maturation promoting factors (MPF), Cyclins and Cyclins dependent kinases, growth factors and growth inhibitory factors. Cell cycle check points, Cell cycle regulation Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumour suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth.	15
Unit II	Cancer: 1. Tumor types: Benign & malignant; sarcoma & carcinoma and leukaemia & lymphoma. 2. Onset of cancer; Metastasis 3. Properties of cancer cells 4. Proto-oncogene; retroviral oncogenes; oncogenes; tumor suppressor genes (RB, p53&) and caretaker genes (BRCA1 & BRCA2). 5. Regulators of signal transduction: APC gene & NF-1 gene. 6. Knudson two hit hypothesis	15
Unit III	Cell death (Apoptosis): 1. Apoptosis and necrosis 2. Caspases: Initiator, executioner & inflammatory 3. Bcl ₂ family proteins: antiapoptotic, apoptotic & derepressors. 4. Extrinsic death receptor pathway (TNF-1 & Fas); intrinsic mitochondrial pathway & mitophagy 5. Inhibitors of apoptotic proteins 6. Caspase independent cell death	15
Unit IV	Aging: The biology of senescence 1. Cellular basis of aging 2. Free radicals, oxidative damage and antioxidants. 3. Telomerases and aging. 4. Diseases: Alzheimer's, Parkinson's, Type II diabetes & Progeria. Regulation of Gene Expression: Lac operon Catabolite repression Trp operon attenuation.	15


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Reference and Reading Books:

1. Cell and Molecular Biology. 8th edition. De Robertis EDP and De Robertis Jr EMF Lippincott Williams & Wilkins 2006.
2. Cell Adhesion Molecules in Cancer and Inflammation. Epenetos A and Pignatelli M. Harwood Academic Publishers, CRC Press 1995.
3. Cancer Stem Cells. Farrar WL. Cambridge University Press. 2009.
4. DNA Repair and Mutagenesis. Friedberg EC, Walker GC and Siede W. ASM Press, Washington DC 1995.
5. BRS Cell Biology and Histology. 6th edition (South Asian Edition), Gartener LP, Hiatt JL, Strum JM. Lippincott Williams & Wilkins, 2010.
6. Molecular biotechnology. Principles and Applications of Recombinant DNA. Glick BR and Pasternak JJ. ASM Press Washington DC, 1998.
7. Cell and Molecular Biology. Concepts and Experiments. 7th edition. Karp G. John Wiley & Sons Inc., New York. 2013.
8. Cell Biology. 6th edition. Karp G. Hoboken, NJ: Wiley 2013.
9. Essential Genes. Levin B Pearson Higher Education .International edition. 2006.
10. Genes IV. Lewin B. Oxford University Press Bombay, 1990.
11. Genes V. International Students Edition. Lewin B. Oxford University Press Oxford, 1994.
12. Genes VII. Lewin B. Oxford University Press, Oxford, 2000.
13. Genes VIII. Lewin B. Pearson Education International .London, Sydney. 2004.
14. Molecular Cell Biology 6th edition. Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira P. W.H Freeman and Company, New York, 2008.
15. Molecular cell Biology. 5th edition. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipursky SL, Darnell J W.H Freeman and Company, New York 2004.
16. Molecular Cell Biology. 4th Edition Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D, Darnell J. W.H Freeman and Company, New York, 2000.
17. Molecular Cell Biology. 7th edition. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A, Scott M P. Mac Millian High Education (International edition) England 2013.
18. Lewin's Cell. 2nd edition. Lynne C, Lingappa VR and Plopper G (Editors). Jones & Barlett Publishers, USA 2011.
19. Essentials of Molecular Biology. Malacinski GM and Friefelder D. Jones and Bartlett Publishers, Boston 1999.
20. Molecular Biology and Biotechnology. Meyers R.A. A Comprehensive Desk Reference. VCH Publishers. 1995.

Radiogenomics and Radiomics Integration

Course outcome:

1. To provide foundational knowledge of radiation biology
2. To develop an understanding of Interaction of radiation with Biomolecules
3. To train students in various Radiation Biology techniques.
4. Radiological methods for molecular and elemental analysis.
5. To equip students with practical knowledge of histological and tissue culture techniques relevant to research and diagnostics.

Course outcomes:

Upon successful completion of this course, students will be able to:

1. Demonstrate knowledge of radiation-based techniques in biology
2. Demonstrate Radiation techniques used in biology.
3. Describe and contrast radiation therapy and therapeutic nuclear medicine
4. Assess current and emerging research areas in tumor radiation biology

Course Title:	Radiogenomics and Radiomics Integration		Course Code: 24MZ09311T
Total Lecture hour: 60		Hours	
Unit I	Fundamentals of Radiation Physics Electromagnetic radiation and radioactivity. Radiation sources and radionuclides. Measurement units of exposed and absorbed radiation. Radiation and Photochemistry Interaction of radiation with matter, excitation and ionization. Radiochemical events relevant to radiation biology. Dosimetry		15

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	Interaction of radiation with Biomolecules Nucleic acids, proteins, lipids and carbohydrates	
Unit II	Cellular effects of radiation Effects of Ionizing and non-ionizing radiation on cells, DNA, chromosomes and membrane, cell survival (including biophysical models). Division delay and cell cycle check points. Mutation DNA repair processes Various repair pathways and their regulation. Mechanistic and regulatory aspects of DNA repair. Role of DNA repair in aging and genetic diseases Biological Dosimetry Micronuclei formation, Chromosome aberration and mutation assays. Systemic effects of radiation Acute, delayed and late radiation effects (with particular reference to hematopoietic, gastrointestinal and central nervous system syndrome). Carcinogenesis and teratogenesis.	15
Unit III	Modification of cellular and systemic response to radiation Radiosensitization and Radioprotection. Behavioral Radiation Biology Effects of radiation on nervous systems (in vitro studies). Effects of low and high doses of radiation on nervous system and behaviour. Radiation Safety Biological basis of ICRP recommendations Radio-ecology and environmental radiation biology Low dose effects of natural and man made radiation, Ultraviolet radiation and environment.	15
Unit IV	Application in Biomedicine Radiation Medicine Radiation Therapy, Therapeutic nuclear medicine, Management of radiation injuries Current Area of Research Tumor Physiology and Radiation Response, Predictive Assays, Adaptive response, Improvement in Tumor Radiotherapy, Emerging new applications Others Low-dose hypersensitivity, Bystander effects, Radiation induced alterations in signal transduction	15
Reference and Reading Books:		
1. Handbook of Radiobiology (Kedar N. Prasad, Taylor & Francis) 2. Radiation Biology for Medical Physicists (C.S. Sureka & Christina Armpilia, 2017) 3. Radiation in Medicine and Biology (Vidyasagar, Jagtap & Yemul, 2017) 4. Principles and Practice of Radiation Therapy by Washington & Leaver 5. Principles and Practice of Radiation Oncology by Perez & Brady 6. Walter and Miller's Textbook of Radiotherapy 7. Radiobiology Textbook (2023, Springer; Editor: Sarah Baatout) 8. Radiobiology for the Radiologist by Eric Hall & Amato Giaccia (8th ed., 2017) 9. Fundamentals of Radiation Biology (Susan Klein et al., 2023).		

Dr. Registrar
Dy. Registrar
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Shahdol (M.P.)

Course Title:	Cell & Molecular Biology Laboratory	Course Code: 24MZO9304P
1. Viable cell counting with hemocytometer (Dye exclusion method). 2. Fixing, dehydrating, embedding, section-cutting, staining and mounting of different tissues. Use of fluorescence and Phase Contrast microscope 3. Paraffin wax blocks preparation for microtomy. 4. Sectioning and processing by Haematoxylin and Eosin staining. 5. Standardization of ocular micrometer 6. Use of stage and ocular micrometer for measuring cell dimensions. 7. Cytochemistry / Histochemistry: Carbohydrate - PAS method 8. Cytochemistry / Histochemistry: Proteins -Ninhydrin method. 9. Detection of enzymes (a) Alkaline phosphatase (b) Acid phosphatase 10. Tissue homogenization and fractionation 11. Comet assay 12. Agarose gel electrophoresis of mammalian DNA 13. SDS-PAGE separation of proteins 14. Separation of protein samples by PAGE/SDS-PAGE (Demonstration). 15. Isolation of Genomic DNA from blood or any other sample. 16. Isoenzymes study using PAGE 17. Electroelution of DNA from electrophoretic gels. 18. Mitosis, Meiosis, various cancer cells & slides from all the above experiments. Slides and tissue blocks to be submitted at the time of practical examination. Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.		

Practical Examination Scheme for Practical Examination

Max Marks: 100

1. Exercise 1
2. Exercise 2
3. Exercise 3
4. Spotting (8 × 3)
5. Seminar
6. Viva Voce
7. Record

Time: 6 hrs

Marks

- | | |
|----|----|
| 20 | 20 |
| 16 | 10 |
| 10 | 24 |
| 24 | 10 |
| 10 | 10 |
| 10 | 10 |


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University,
Shukhnawara (Jhajhar)
Sikar