

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
CORE AND ELECTIVES COURSES

SEMESTER	COURSE CODE	CORE COURSES	COURSE CODE	ELECTIVE COURSES
I	ZOO-I.C-1	Animal Diversity : Non Chordates		
	ZOO-I.C-2	Cell and Molecular Biology		
II	ZOO-II.C-3	Diversity and Biological Systems of Chordates		
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics		
III	ZOO-III.C-5	Human Physiology	ZOO-III.E-1	Vertebrate Endocrinology
			ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology
			ZOO-III.E-3	Environmental Toxicology
			ZOO-III.E-4	Parasitology
IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation	ZOO-IV.E-5	Animal cell culture and Applications
			ZOO-IV.E-6	Aquaculture and Fisheries
			ZOO-IV.E-7	Immunology
			ZOO-IV.E-8	Evolutionary Biology
V	ZOO-V.C-7	Developmental Biology	ZOO-V.E-9	Molecular Genetics and Forensic Science
			ZOO-V.E-10	Economic Zoology
			ZOO-V.E-11	Ecology and Ethology
			ZOO-V.E-12	Fish Preservation and Processing
VI	ZOO-VI.C-8	Wildlife Biology	ZOO-VI.E-13	Health and Nutrition
			ZOO-VI.E-14	Basic and Applied Entomology
			ZOO-VI.E-15	Laboratory Techniques in Pathology
			ZOO-VI.E-16	Bio Entrepreneurship

PROGRAMME: BSC ZOOLOGY CORE COURSES

CORE COURSES FOR ZOOLOGY SINGLE MAJOR / DOUBLE MAJOR		
SEMESTER	COURSE CODE	COURSE TITLE
1	ZOO-I.C-1	Animal Diversity : Non Chordates
1	ZOO-I.C-2	Cell and Molecular Biology
2	ZOO-II.C-3	Diversity and Biological Systems of Chordates
2	ZOO-I.C-4	Fundamentals of Animal and Human Genetics
3	ZOO-III.C-5	Human Physiology
4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
5	ZOO-V.C-7	Developmental Biology
6	ZOO-VI.C-8	Wildlife Biology

CORE COURSES FOR ZOOLOGY MAJOR - MINOR		
SEMESTER	COURSE CODE	COURSE TITLE
1	ZOO-I.C-1	Animal Diversity : Non Chordates
2	ZOO-II.C-3	Diversity and Biological Systems of Chordates
3	ZOO-III.C-5	Human Physiology
4	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
5	ZOO-V.C-7	Developmental Biology
6	ZOO-VI.C-8	Wildlife Biology

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**PROGRAMME: BSC ZOOLOGY
ELECTIVE COURSES**

ELECTIVE COURSES FOR BSc ZOOLOGY		
SEMESTER	COURSE CODE	COURSE TITLE
Odd semester	ZOO-III.E-1	Vertebrate Endocrinology
	ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology
	ZOO-III.E-3	Environmental Toxicology
	ZOO-III.E-4	Parasitology
	ZOO-V.E-9	Molecular Genetics and Forensic Science
	ZOO-V.E-10	Economic Zoology
	ZOO-V.E-11	Ecology and Ethology
	ZOO-V.E-12	Fish Preservation and Processing
Even semester	ZOO-IV.E-5	Animal cell culture and Applications
	ZOO-IV.E-6	Aquaculture and Fisheries
	ZOO-IV.E-7	Immunology
	ZOO-IV.E-8	Evolutionary Biology
	ZOO-VI.E-13	Health and Nutrition
	ZOO-VI.E-14	Basic and Applied Entomology
	ZOO-VI.E-15	Laboratory Techniques in Pathology
	ZOO-VI.E-16	Bio Entrepreneurship



COURSE STRUCTURE FOR PROGRAMME: BSC ZOOLOGY

STRUCTURE		CREDITS	SUBJECTS & PAPERS	CC Major + Project	CC Minor	Elective
Component A (84 Credits)	CHOICE – 1 Single Major	32+4	8 Core Papers (Major) + Project Paper	8 + 1		
		48	12 Elective Papers (Major)		--	12
	CHOICE – 2 Major and Minor	32+4	8 Core Papers (Major) + Project Paper	8 + 1		
		24	6 Core Papers (Minor)		6	
		24	6 Elective Papers (Major)			6
	CHOICE – 3 Double Majors	32+4	8 Core Papers (Major 1) + Project Paper	8 + 1	--	
		32	8 Core Papers (Major 2)	8	--	
16		2+2 Elective Papers (Major 1 / Major 2)			4	
STRUCTURE		CREDITS	GENERAL SUBJECTS & PAPERS	Compulsory		Elective
Component B (36 Credits)	Compulsory Subjects	8	A. Languages (Two Papers of 4 Credits each)	2		
		8	B. (1) Academic Writing (2) Cyber Security	2		
		2 + 2	C. EVS (Two papers of 2 Credits each)	2		
		8	D. (1) Statistical Methods (2) Research Writing	2		
		8	E. Interdisciplinary (Arts / Science) (Two Papers of 4 Credits each)			2
Component C (6 Credits)	Extra-curricular	2	Music, Arts (2 Credits)			1
		2	Sports (2 Credits)			1
		2	NCC, NSS (2 Credits)			1
Component D (4 Credits)	Internship	4	Internship (Minimum 1 Month)	1		
Abbreviations:		CC – Core Compulsory CE – Core Electives CP – Core Project CM – Core Minor GC – General Compulsory GE – General Electives I – Internship				

COURSE DISTRIBUTION FOR PROGRAMME: BSC ZOOLOGY

Distribution of courses (Single Major)						
Semesters	I	II	III	IV	V	VI
Courses	2CC	2CC	CC	CC	CC	CC
	GC - B	GC - B	3CE	3CE	3CE	3CE
	LANG	LANG	GC - D	GC - D	GC - E	GC - E
	EVS	EVS			PROJ	PROJ
Total	4.5	4.5	5	5	5.5	5.5

Distribution of Courses (Major - Minor)						
Semesters	I	II	III	IV	V	VI
Courses	2CC	2CC	CC	CC	CC	CC
	GC - B	GC - B	CE	CE	2CE	2CE
	LANG	LANG	GC - D	GC - D	GC - E	GC - E
	CCm	CCm	CCm	CCm	CCm	CCm
			EVS	EVS	PROJ	PROJ
Total	5	5	4.5	4.5	5.5	5.5

Distribution of Courses (Double Majors)						
Semesters	I	II	III	IV	V	VI
Courses	2CC - 1	2CC - 1	CC - 1	CC - 1	CC - 1	CC - 1
			CE	CE	CE	CE
	LANG	LANG	2GC - B, D	2GC - B, D	GC - E	GC - E
	2CC - 2	2CC - 2	CC - 2	CC - 2	CC - 2	CC - 2
					EVS	EVS
					PROJ	PROJ
Total	5	5	5	5	5	5

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM - CORE COURSES

SEMESTER	COURSE CODE	CORE COURSES
I	ZOO-I.C-1	Animal Diversity : Non Chordates
	ZOO-I.C-2	Cell and Molecular Biology
II	ZOO-II.C-3	Diversity and Biological Systems of Chordates
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics
III	ZOO-III.C-5	Human Physiology
IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation
V	ZOO-V.C-7	Developmental Biology
VI	ZOO-VI.C-8	Wildlife Biology

SEMESTER –I:

CORE COURSE : ANIMAL DIVERSITY: NON CHORDATES

COURSE CODE:	ZOO-I.C-1
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To be familiar with the different non-chordate phyla.• To know the general and distinguishing characters of each of them.• To study how the different systems evolved in their complexity.• To compare and contrasts the life processes in different phyla.
LEARNING OUTCOME:	At the end of the course, the students will be familiar with the non-chordate world that surrounds us. They will be able to appreciate the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms. Students will be able to identify the invertebrates and classify them upto the class level. Students will understand the basis of life processes in the non-chordates.

ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES

MODULE	TOPICS	CONTACT HOURS
Module 1: Evolution of Animal Diversity and Diversity of lower non chordates	1.1 Non chordate evolution and diversity 1.2 Taxonomy and phylogeny of animals 1.3 Invertebrate cladogram 1.4 Protista Classification and general characters upto class for the following phyla: 1.5 Porifera 1.6 Cnidaria 1.7 Platyhelminthes 1.8 Aschelminthes 1.9 Annelida	15
Module 2: Diversity of higher Non Chordates And Biological systems of non chordates 1	Classification and general characters upto class for the following phyla: 3.1: Onychophora 3.2: Arthropoda 3.3: Mollusca 3.4: Echinodermata 3.5: Hemichordata Comparison of life processes such as nutrition, sensory and neural control and coordination, sense organs	15
Module 3: Biological systems of Non Chordates 2	Comparison of life processes (Phylum Porifera to hemichordate) such as: <ul style="list-style-type: none">• blood vascular system,• exoskeleton,• endoskeleton,• locomotion and muscular system,• respiration,• excretion,• Reproduction and development.	15

PRACTICAL COMPONENT OF ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES		
(DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1.	Identification of organisms from phylum protozoa to phylum Hemichordata	06
2.	Observation of permanent slides	03
3.	Mountings: Cockroach mouth parts, prawn appendages	02
4.	Field trip to terrestrial environment to study the invertebrates in their natural habitats	01

REFERENCE BOOKS:

1. Barnes R.D. (2000). Invertebrate Zoology.Hall Saunders International Edition, London.
2. Barrington E.J.W. 1979. Invertebrate structure and Function.John Wiley and Sons Inc.
3. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
4. Marshall A.J.and W.D. Williams. 1974. Textbook of Zoology. Macmillan.
5. Pechenik J.A.(2002). Biology of the invertebrates. Tata McGraw hill Publishing company limited, New Delhi .

REFERENCE BOOKS FOR PRACTICALS:

- 1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual.Morton Publishing Co. Austin Community College.
 - 2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.
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ZOO-I.C-2 : CELL AND MOLECULAR BIOLOGY**CORE COURSE : CELL AND MOLECULAR BIOLOGY**

COURSE CODE:	ZOO-I.C-2
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course will give firm and rigorous foundation in the principles of modern molecular and cellular biology. It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. Students will also learn current molecular biological techniques that are used to study cell biology. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">• Develop deeper understanding of what life is and how it functions at cellular level.• Describe cellular membrane structure and function, fine structure and function of cell organelles.• Perform a variety of molecular and cellular biology techniques.

MODULE	TOPICS	CONT ACT HOUR S
MODULE 1: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY (15 Hrs)	Unit 1: MICROSCOPY <ul style="list-style-type: none"> • Light Microscopy • Electron Microscopy (SEM, TEM, IEM,STEM). 	04
	Unit 2: CELL STUDY METHODS <ul style="list-style-type: none"> • Cell Fractionation, Chromatography and electrophoresis • X-ray diffraction and NMR spectroscopy • Radioisotope tracer technique, Autoradiography, intracellular electrodes 	04
	Unit 3: MOLECULES IN CELL. <ul style="list-style-type: none"> • Micromolecules in cells: Sugars, Fatty acids, aminoacids, Nucleotides. • Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats. 	05
	Unit 4: CHEMICAL BONDS IN BIOMOLECULES <ul style="list-style-type: none"> • covalent bonds, ionic bonds, noncovalent interactions 	02
MODULE 2: CELL ARCHITECTURE (15 Hrs)	Unit 5: MEMBRANE STRUCTURE AND MEMBRANE PROTEINS <ul style="list-style-type: none"> • lipid bilayer – composition and structural organization (amphipathic phospholipids, Fluidity of cell membrane) • Membrane Proteins –structure and function (transmembrane proteins, peripheral membrane proteins) • Phospholipids, sphingolipids, Cholesterol in cell membrane. 	06
	Unit 6: MOLECULAR STRUCTURE AND FUNCTION <ul style="list-style-type: none"> • Plasma Membrane • Cell matrix: Physical nature and Properties. • Nucleus: Ultra Structure and function • Mitochondria: Ultra Structure and functions • Endoplasmic Reticulum: ultra structure, modifications, functions 	06
	UNIT 7: MOLECULAR STRUCTURE AND FUNCTION <ul style="list-style-type: none"> • Golgi Complex: detailed structure and function • Ribosomes- Structure and function • Microsomes: Lysosome-morphology and function, Microbodies • Cytoskeleton – Microtubules, Microfilaments, intermediate filaments 	03
MODULE 3: CELLULAR TRANSPORT OF PROTEINS AND VESICLES (15 Hrs)	Unit 8: TRANSPORT ACROSS CELL MEMBRANES <ul style="list-style-type: none"> • Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis) • Transporters and their function- passive transporters, Pumps (Na⁺, K⁺, Ca⁺⁺), functions of transporters. • Ion Channels - ion channels activities, regulation of opening and closing of channels. • Protein transport into organelles (nucleus, mitochondria,ER). 	10
	Unit 9: VESICULAR TRANSPORT. <ul style="list-style-type: none"> • Vesicular transport – transport of soluble proteins, vesicle budding, vesicle docking, endocytic pathways • General principles of cell signaling, G-Protein coupled receptors, enzyme coupled receptors 	05

PRACTICAL COMPONENT OF ZOO-I.C-2: CELL AND MOLECULAR BIOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1)	Introduction to Lab techniques – Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices	02
2)	Cytochemistry: Localisation of Proteins, Carbohydrates & fats using different stains.	03
3)	Comparison of membrane permeability – Cellophane and Chick intestine.	01
4)	Osmotic studies – Using Human Red blood cells.	01
5)	Permanent slides: <ul style="list-style-type: none"> - Mitotic stages - Meiotic stages (mounting from grasshopper testes) - Histology - Study of different cell types (animal cells) 	03
6)	Technique of Agarose gel electrophoresis (Observation of technique)	01
7)	Protein study – SDS-PAGE (Observation of technique)	01

REFERENCE BOOKS:

Essential books:

- 1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Garland Science Taylor & Francis Group, UK.*
- 2) *Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

Supplementary Reading:

- 3) *Gupta PK (2003): Cell and Molecular Biology, Second Edition, Rakesh Kumar Rastogi for Rastogi Publications, Meerut, New Delhi, India.*
- 4) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
- 5) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

REFERENCE BOOKS FOR PRACTICALS:

- 1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Garland Science Taylor & Francis Group, UK.*
- 2) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
- 3) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
- 4) *Alberts B, Johnson A, Lewis J, Raff M, Robertis K, Walter P (2008): Molecular Biology of the Cell, Fifth Edition, Published by Garland Science, Taylor & Francis Group, UK.*

SEMESTER – II

CORE COURSE: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES	
COURSE CODE:	ZOO-II.C-3
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To be familiar with the different Chordate phyla.• To know the general and distinguishing characters of each of them.• To compare and contrast the major biological systems amongst them.
LEARNING OUTCOME:	At the end of the course, the students will be familiar with the chordate world that surrounds us. They would be able to identify the different chordates upto the order. They will understand the functioning and mechanism of the various biological systems in the chordates.

ZOO-II.C-3: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES		
MODULE	TOPICS	CONTACT HOURS
MODULE 1: Diversity of chordates(upto order)	1.1: Chordata: General plan of organization and Outline classification 1.2: General characters and classification of Protochordates 1.3: General characters and classification of Agnatha 1.4: General characters and classification of Pisces 1.5: General characters and classification of Amphibia 1.6: General characters and classification of Reptilia 1.7: General characters and classification of Aves 1.8: General characters and classification of Mammalia	15
MODULE 2: Biological Systems I	3.1: Integument: Pisces, Amphibia, Reptilia, Aves, Mammalia 3.2: Locomotory apparatus: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Digestive system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.4: Respiratory system: Pisces , Lungs in Amphibia, Reptilia , Aves, Mammalia	15
MODULE 3: Biological systems - II	3.1: Circulatory system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.2: Brain and cranial nerves: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Reproductive system: Pisces , Amphibia, Reptilia , Aves, Mammalia	15

PRACTICAL COMPONENT OF ZOO-II.C-3: DIVERSITY OF CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1.	Identification and Systematic classification of organisms from protochordates to mammalia	05
2.	Mounting of scales and chromatophores in fishes	01
3.	Observation of general viscera of chordate phyla	01
4.	Observation and study of nests of birds- crow, baya weaver, munia, sun bird (any three)	01
5.	Identification of Indian venomous and non venomous snakes with the help of keys provided (four each)	01
6.	Mounting of pecten of eye (chick)	01
7.	Mounting of hyoid apparatus of chick; observation of hyoid apparatus of reptiles and mammals	01
8.	Overview of skull from fish to mammals	01
9.	Observation of permanent slides (amphioxus, doliolum, salpa)	01
10.	Field trip to fish landing site and wild life sanctuary	02

REFERENCE BOOKS:

1. Cleveland Hickman Jr., Roberts Larry, Susan Keen, Allan Larson and Eisenhour D (2014). Animal Diversity. McGraw Hill Science.
2. Kardong K(2011). Vertebrates: Comparative anatomy, evolution, function. McGraw-Hill Higher Education.
3. Kent G.C. and Carr R.K. (2000). Comparative anatomy of the vertebrates. McGraw-Hill Higher Education.
4. Young J.Z. (2006). The life of vertebrates. Radha Press Delhi, Indian Edition.

REFERENCE BOOKS FOR PRACTICALS:

- 1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual. Morton Publishing Co. Austin Community College.
- 2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

COURSE CODE:	ZOO-II.C-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. Students will receive good foundation of chromosome structure, its aberrations and inheritance patterns of traits and disease which will help one to develop conceptual skills to address questions in genetic research.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">• Describe the basic structure of genes and chromosomes.• Relate an organism’s genotype and phenotype and explain the role of genes in inheritance.• Understand the reason why a given genotype does not always result in the same phenotype• Demonstrate knowledge of genetic principles and their application in society• Construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

MODULE	TOPICS	CONTACT HOURS
MODULE 1: TRANSMISSION GENETICS	UNIT 1: MODES OF INHERITANCE <ul style="list-style-type: none"> • Mendel's laws of inheritance, test cross, back cross • Gene interactions: 9:3:3:1/12:3:1 / 9:3:4 / 9:6:1 / 9:7 / 15:1 / 13:3. lethal genes, penetrance. • Inheritance of Multiple Alleles and Multiple genes 	06
	UNIT 2: PATTERN OF INHERITANCE BY PEDIGREES <ul style="list-style-type: none"> • Construction of Pedigrees • Analysis of Pedigree analysis: autosomal dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance • Sex limited and Sex influenced and multifactorial inheritance disorders in humans 	09
MODULE 2: CHROMOSOME STRUCTURE AND ABNORMALITIES	UNIT 3: CHROMOSOME STRUCTURE <ul style="list-style-type: none"> • Chromosome morphology- chromatid, Centromere, secondary constriction, chromomere • Heterochromatin and euchromatin • Chromosome structure and organization. • Human chromosomes and karyotype. 	06
	UNIT 4: CHROMOSOMAL ABERRATION <ul style="list-style-type: none"> • Numerical aberrations: Types- Aneuploidies and Euploidies, Mosaicism, Numerical aberrations in humans • Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications. Structural aberrations in humans. 	09
MODULE 3: GENE MUTATIONS, SEX DETERMINATION.	UNIT 5: GENETIC MUTATIONS. <ul style="list-style-type: none"> • characteristics of mutations • classification of mutations (Spontaneous, Induced) • molecular basis of mutations • Mutagens – physical and chemical 	08
	UNIT 6: SEX DETERMINATION. <ul style="list-style-type: none"> • Environmental Sex Determination – hormonal, egg size, incubation temperature. • Chromosomal sex determination - XX^{\ominus} and XO^{σ}, XO^{\ominus} and XX^{σ}, ZW^{\ominus} and ZZ^{σ}, XX^{\ominus} and XY^{σ}, Diploid female and Haploid male, single gene effect. • Molecular basis of sex determination: Geneic imbalance, Sex index, Intersex and gynandomorphs, X/A Ratio. • Sex determination by Y linked genes, Dosage compensation, X-inactivation 	07

PRACTICAL COMPONENT OF ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS. DURATION - 02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Verification of Mendel's laws - monohybrid cross	01
2)	Verification of Mendel's laws - dihybrid cross	01
3)	Manual Karyotyping of human chromosome plates: 1) Normal Male and Female 2) Downs syndrome 3) Turners Syndrome	04
4)	Drosophila Culture technique	01
5)	Study of Mutants of Drosophila	01
6)	Exercises for Multiple alleles and Multiple genes	02
7)	Construction of pedigrees	01
8)	Analysis and interpretation of Pedigrees	01

REFERENCE BOOKS FOR THEORY:

- 1) Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.
- 2) De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eighth Edition. Wolter Kluwer Publication, Philadelphia.
- 3) Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.
- 4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.
- 5) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
- 6) Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.
- 7) Marcus A(2011): Genetics, MJP Publishers, Chennai.
- 8) Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.
- 9) Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.

REFERENCE BOOKS FOR PRACTICALS:

- 1) Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.
- 2) Marcus A(2011): Genetics, MJP Publishers, Chennai.
- 3) Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.
- 4) Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.

SEMESTER –III

CORE COURSE :HUMAN PHYSIOLOGY

COURSE CODE:	ZOO-III.C-5
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. The course is designed to expand physiological concepts presented in prerequisite courses.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">• describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body• develop understanding of the functional relationships of anatomical structures to one another

ZOO-III.C-5: HUMAN PHYSIOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: PHYSIOLOGY OF DIGESTION AND RESPIRATION (15 Hrs)	UNIT 1: <i>DIGESTIVE SYSTEM</i> <ul style="list-style-type: none"> • Structural organization, histology and functions of gastrointestinal tract and its associated glands; • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins. • Role of gastrointestinal hormones on the secretion and control of enzymes of Gastrointestinal tract 	08
	UNIT 2: <i>RESPIRATORY SYSTEM</i> <ul style="list-style-type: none"> • Histology of trachea and lung; • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; • Transport of oxygen in the blood oxygen- hemoglobin & myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; • Buffering action of blood and haemoglobin Control of respiration 	07
MODULE 2: PHYSIOLOGY OF EXCRETION AND CIRCULATION (15 Hrs)	UNIT 3: <i>EXCRETORY SYSTEM</i> <ul style="list-style-type: none"> • Structure of kidney and its histological details, Renal blood supply; Mechanism urine • Formation and its regulation, Regulation of acid-base balance. 	05
	UNIT 4: <i>CIRCULATORY SYSTEM</i> <ul style="list-style-type: none"> • An outline structure of heart; Coronary circulation; structure of conducting and working • Myocardial fibers. Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart, nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram • Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis and Coagulation of blood; Disorders of blood. 	10
MODULE 3: PHYSIOLOGY OF NERVOUS SYSTEM, MUSCLES AND REPRODUCTIVE SYSTEM (15 hrs)	UNIT 5: <i>NERVOUS SYSTEM</i> <ul style="list-style-type: none"> • Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; • types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types -reflex arc • Physiology of hearing and vision 	06
	UNIT 6: <i>MUSCLE</i> <ul style="list-style-type: none"> • Histology of different types of muscle; • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor Unit, summation & tetanus 	04
	UNIT 7: <i>REPRODUCTIVE SYSTEM</i> <ul style="list-style-type: none"> • Histology of male and female reproductive systems. • Puberty, Physiology of male and female reproduction. 	05

PRACTICAL COMPONENT OF ZOO-III.C-5: HUMAN PHYSIOLOGY (DURATION -02 HRS /WEEK)		
SR. NO	PRACTICAL	NO. OF PRACTICALS
1)	Enumeration of red blood cells / WBC using haemocytometer	02
2)	Estimation of haemoglobin using Sahli's haemoglobinometer	01
3)	Determination of activities of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)	02
4)	Temporary preparation of Striated muscle fibers and nerve cells.	02
5)	Urine analysis (for organic, inorganic and abnormal components)	03
6)	Examination of sections of mammalian tissues: Lung, Kidney, Gonads, Intestine, Muscles, Spinal cord, Bone and cartilage	02

REFERENCE BOOKS:

Essential books:

1. Singh HD(2011):*Textbook of Human Physiology, S Chand Publishers, New Delhi.*
2. Widmaier, Raff, & Strang(2008), *Vander's Human Physiology: The Mechanisms of Body Function, 12th edition, McGraw Hill,. ISBN 978-0-07-337810-7*
3. Tortara G J and Derrickson BH(2009). *Principles of Anatomy and physiology, 12th Edition. John Wiley & sons, Inc.*
4. Guyton Ac and Hall JE(2011). *Testbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company.*

Supplementary Reading:

5. Openstax College (2013). *Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)*
6. Forciea B (2012). *An eText of Human Anatomy and Physiology(Ebook).*
7. Wingerd B(2008). *The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

REFERENCE BOOKS FOR PRACTICALS:

1. Openstax College (2013). *Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)*
2. Forciea B (2012). *An eText of Human Anatomy and Physiology(Ebook).*
3. Wingerd B(2008). *The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

SEMESTER - IV

CORE COURSE: BIOCHEMISTRY AND METABOLIC REGULATION	
COURSE CODE:	ZOO-IV.C-6
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To understand the basic principles that govern the functioning of living systems• To know the structure of biomolecules and the role they play in governing life processes through the pathways• To be familiar with enzymes and their activities
LEARNING OUTCOME:	At the end of the course, the students will be able to understand better the chemical basis in life. They will appreciate better the interactions between the biological molecules.

ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Fundamentals of biochemistry and Carbohydrate metabolism	1.1 Principles of pH, buffer, thermodynamics 1.2 Enzymes: classification, properties of enzyme, enzyme kinetics, Michaelis-Menten Equation, enzyme inhibition 1.3 Carbohydrate structure, aerobic and anaerobic glycolysis, Citric acid cycle, glycogenesis, glycogenolysis, Pentose phosphate pathway, 1.4 Diabetes mellitus	15
MODULE 2: Lipid and Protein metabolism	2.1: Lipid: -structure and classification, -fatty acid synthesis -fatty acid oxidation (saturated and unsaturated), - metabolism of glycerophospholipids, sphingolipids, cholesterol - disorders: fatty liver types (NAFL, AFL) 2.2 Protein: - structure (primary, secondary, tertiary) and classification -amino acid biosynthesis, nucleotide biosynthesis, - amino acid catabolism, urea cycle, Fate of carbamoyl P, - Hyper uricemia	15
MODULE 3: Nucleotide metabolism and integration of metabolism	3.1 Biosynthesis of purine and pyrimidine (de novo and salvage pathway) 3.2 Degradation of purine and pyrimidine 3.3 Interconversions between the three principal components 3.4 Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)	15

PRACTICAL COMPONENT OF ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1)	Principle and working of spectrophotometer	01
2)	Estimation of reducing sugars DNSA method	01
3)	Estimation of protein – Folin Lowry’s method	01
4)	Estimation of fatty acids by titration method	01
5)	Separation of lipids by thin layer chromatography	02
6)	Colorimetric estimation of liver glycogen of chick by Anthrone method	02
7)	Effect of substrate concentration on amylase activity	01
8)	Estimation of DNA by DPA method	01
9)	Isolation of lecithin and cholesterol from yolk	02

REFERENCE BOOKS:

1. David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
2. Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.
3. Harvey, A.R. and Ferrier, D. (2011). Lippincott’s Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.
4. Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition.

REFERENCE BOOKS FOR PRACTICALS:

Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry. Tata McGraw Hill Education ,UK.

SEMESTER – V

CORE COURSE:DEVELOPMENTAL BIOLOGY	
COURSE CODE:	ZOO-V.C-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To understand the processes of fertilization, polyspermy and activation of egg metabolism• To know the basics of animal development, specifically in sea urchin and chick• To be familiar with the processes that help in the establishment of basic plan of development
LEARNING OUTCOME:	<ul style="list-style-type: none">• At the end of the course, the students will be able to understand the basic plan of animal development. They will be familiar with the processes which occur during the course of development in invertebrates and vertebrates. This paper will provide the basic knowledge of developmental biology.

ZOO-V.C-7: CORE COURSE:DEVELOPMENTAL BIOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Early embryonic development and early development of model organism: sea urchin	1.1: Introduction to cell division: mitosis and meiosis	} 05
	1.2: Fertilization: structure of the gametes	
	1.3: Species recognition specificity of egg and sperm	} 04
	1.4: Gamete fusion and the prevention of polyspermy	
	1.5: The activation of egg metabolism	} 06
	1.6: Fusion of the genetic material	
	1.7: Rearrangement of the egg cytoplasm	
	1.8: Sea Urchin: cleavage, gastrulation, blastula formation	
	1.9: Fate maps and the determination of sea urchin blastomeres, gastrulation	
	1.10: Embryonic stem cells: Pluripotency and totipotency	
MODULE 2: Early development of model organism: chick	2.1: Chick: cleavage, gastrulation, primitive streak, epiboly	} 05
	2.2: Axis formation in the chick embryo	07
	2.3: Development upto three days of incubation	03
	2.4: Extra embryonic membranes of chick development, structure and functions of yolk sac, amnion, chorion and allantois	
MODULE 3: Growth and regeneration	3.1: Nuclear transplantations and embryonic inductions	04
	3.2: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation	06
	3.3: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates	05
	3.4: Hejmadi Mohanty's experiment	

PRACTICAL COMPONENT OF ZOO-V.C-7 (DURATION -02 HRS /WEEK)		
SR. NO.	PRACTICAL	NO. OF PRACTICALS
1)	Observation of developmental stages of sea urchin: cleavage, blastula, gastrula (permanent slides)	01
2)	Study of morphogenetic movement <i>in vivo</i> in hens egg using vital staining technique by preparing window opening	01
3)	<i>In vitro</i> observation of different extra embryonic membrane in a six days old chick embryo	01
4)	Preparation of permanent slides of chick embryo: 24 hours, 36 hours, 48 hours, 72 hours	06
5)	Effect of retinoic acid on regeneration of fin in fish	01
6)	Mounting of eye vesicles and limb buds of six day old chick embryo	01
7)	Effect of lead acetate / mercuric chloride on the neural tube development of chick embryo	01

REFERENCE BOOKS:

1. Gilberts, S.F. (2013). *Developmental Biology*, Sinauer Associates, Sunderland.
2. Jain, P.C. (2013). *Elements of developmental biology*, Vishal Publications, Jalandhar
3. Slack, J.M.W. (2006). *Essential developmental biology*. Blackwell Publishing, U.K.

REFERENCE BOOKS FOR PRACTICALS:

1. Beffa – Mari, M. And J. Knight (2005) *Key experiments in practical developmental biology*. Cambridge University Press.
2. Tyler, M.S. (2000) *Developmental biology, a guide for experimental study*. Sinauer Associates, Inc. Publishers, Sunderland, MA.

SEMESTER – VI

CORE COURSE: WILDLIFE BIOLOGY	
COURSE CODE	ZOO-VI-C-8
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">▪ Know the techniques used in assessment and monitoring of wildlife.▪ Know about the diversity, extent, range of wildlife population dynamics.

ZOO-VI-C-8: WILDLIFE BIOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: INTRODUCTION TO WILDLIFE	<p>UNIT 1: Introduction to wildlife</p> <ul style="list-style-type: none"> • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. <p>UNIT 2: Evaluation and management of wildlife</p> <ul style="list-style-type: none"> • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS. 	15
MODULE 2: POPULATION ESTIMATION AND PROTECTED AREAS	<p>UNIT 3: Population estimation</p> <ul style="list-style-type: none"> • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. <p>UNIT 4: Protected areas</p> <ul style="list-style-type: none"> • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves. 	15
MODULE 3: MANAGEMENT OF WILDLIFE	<p>UNIT 5: Management of habitats</p> <ul style="list-style-type: none"> • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, <p>UNIT 6: Management planning of wildlife in protected areas</p> <ul style="list-style-type: none"> • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbation. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). <p>UNIT 8: Management of critical population</p> <ul style="list-style-type: none"> • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea. 	15

PRACTICAL COMPONENT OF WILDLIFE BIOLOGY		
ZOO-VI-C-8: (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	PRACTICAL	NO. OF PRACTICALS
1)	Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds	02
2)	Acquainting oneself with basic equipment needed in wildlife studies; use, care and maintenance (compass, binoculars, spotting scope, range finders, Global Positioning System, various types of cameras and lenses)	02
3)	Familiarization and study of species specific evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, feathers, etc. – case study	02
4)	Demonstration of various field techniques for flora and fauna: PCQ, Ten tree method, Circular, Square and rectangular plots, Parker’s 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment	03
5)	Trail / transect-quadrante monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip)	03

REFERENCE BOOKS:

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

**PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM - ELECTIVE COURSES**

	SEMESTER	COURSE CODE	CORE COURSES
ODD SEMESTER	III	ZOO-III.E-1	Vertebrate Endocrinology
		ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology
		ZOO-III.E-3	Environmental Toxicology
		ZOO-III.E-4	Parasitology
	V	ZOO-V.E-9	Molecular Genetics and Forensic Science
		ZOO-V.E-10	Economic Zoology
		ZOO-V.E-11	Ecology and Ethology
		ZOO-V.E-12	Fish Preservation and Processing
EVEN SEMESTER	IV	ZOO-IV.E-5	Animal cell culture and Applications
		ZOO-IV.E-6	Aquaculture and Fisheries
		ZOO-IV.E-7	Immunology
		ZOO-IV.E-8	Evolutionary Biology
	VI	ZOO-VI.E-13	Health and Nutrition
		ZOO-VI.E-14	Basic and Applied Entomology
		ZOO-VI.E-15	Laboratory Techniques in Pathology
		ZOO-VI.E-16	Bio Entrepreneurship

ODD SEMESTER

SEMESTER – III

ELECTIVE COURSE: ENDOCRINOLOGY	
COURSE CODE:	ZOO-III.E-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To study the endocrine organs of vertebrates• To understand the underlying principles of hormone functions• To gain an insight into the current and important issues in endocrinology
LEARNING OUTCOME:	At the end of the course, the students will be familiar with all the endocrine organs and their functions in body growth, metabolism, reproduction and development. They will be able to appreciate better the contemporary issues in endocrinology.

ZOO-III.E-1: ENDOCRINOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Anatomy and histology	Unit 1: 1.1 Aim and scope of endocrinology, 1.2 techniques in endocrinology - histology, histochemistry, immunocytochemistry, in situ hybridisation, radio immune assay, surgical techniques, 1.3 regulation of hormone secretion: feedback mechanisms - positive, negative, short loop, long loop	15
	Unit 2: 2.1 Anatomy and histology of endocrine glands- Pituitary, Pineal gland, Thyroid, Parathyroid, Thymus, Adrenal, Endocrine pancreas, GI tract, Endocrine hypothalamus, Gonads, Placenta	
MODULE 2: Hormones	Unit 3: 3.1 Classification of hormones 3.2 Hormone structure 3.3 Biological actions of hormones	15
	Unit 4: 4.1 Mechanisms of hormone action 4.2 Receptor and its regulation 4.3 Steroid and peptide hormones actions	
	Unit 5: 5.1 Hormones and Homeostasis - Calcium and glucose	
MODULE 3: Pathological conditions	Unit 6: 6.1 Biosynthesis and secretion of hormones - steroid hormones, thyroid hormones	15
	Unit 7: 7.1 Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors	
	Unit 8: 8.1 Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insipidus	

PRACTICAL COMPONENT OF ZOO-II.C-3: Vertebrate Endocrinology (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1)	Histological slides of Endocrine hypothalamus, Gonads, Placenta pituitary, Pineal gland, thyroid gland, Parathyroid, Thymus, adrenal gland, pancreas, ovary, testis	04
2)	Display of Pituitary and gonads in fishes/chick	03
3)	Preparation of histological slides using microtomy	05

REFERENCE BOOKS:

1. David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.
2. Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.
3. Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.
4. Yadav, P.R. (2004) Endocrinology. Discovery Publishing House, New Delhi.

ELECTIVE COURSE: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY

COURSE CODE:	ZOO-III-E-2
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	To provide a comprehensive survey of microbiology with basic information on bacteria and learn the fundamentals of biotechnological techniques.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">• Gain working knowledge of basic bacterial laboratory techniques, as well as the foundations of biotechnological tools.• Students will also master the basic laboratory skills and techniques necessary to work efficiently in a microbiology laboratory and perform techniques of gene insertion and selection of recombinant plasmids.

ZOO-III-E-2: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Microbiology (15 hrs)	1: Introduction to Microorganisms-Bacteria <ul style="list-style-type: none"> ○ Structure and Identification of bacteria(morphological types) ○ Nutritional types ○ Nutritional requirements 	08
	2: Isolation and Culture of Bacteria: <ul style="list-style-type: none"> ○ Cultivation of bacteria ○ Different methods of isolation and maintenance of pure cultures ○ Culture characteristics 	04
	3: Use of microorganisms in biotechnology-An overview: <ul style="list-style-type: none"> ○ Production of valuable substances ○ Fuel Production, recovery of minerals and oils ○ Microorganisms in bioassays ○ Food and agriculture sector ○ Medicine and health 	03
MODULE 2: Tools in Biotechnology (15 hrs)	4: Scope and importance of Biotechnology <ul style="list-style-type: none"> ○ Definition ○ Contribution and importance of biotechnology 	03
	5: Nucleic Acid Enzymology: <ul style="list-style-type: none"> ○ Restriction enzymes, Ligases, Alkaline phosphatase ○ Polynucleotide kinase, Terminal Transferases, S1 Nuclease ○ Polymerases, Reverse transcriptase 	07
	6: Gene Cloning vectors: <ul style="list-style-type: none"> ○ Plasmids, Bacteriophage, cosmids ○ Shuttle and expression vectors 	05
MODULE 3: Genetic Engineering (15 hrs)	7: Techniques in genetic engineering: <ul style="list-style-type: none"> ○ Gene transfer methods ○ Methods of Labeling Nucleic acids ○ Nucleic acid Hybridization ○ Polymerase chain reaction 	05
	8: Recombinant DNA technology: <ul style="list-style-type: none"> ○ Procedure / Technique 	04
	9: Blotting Techniques: <ul style="list-style-type: none"> ○ Southern Blotting ○ Northern Blotting ○ Western Blotting 	03
	10: DNA sequencing techniques: <ul style="list-style-type: none"> ○ Chemical Degradation method ○ Chain termination method ○ Automated Sequencing 	03

**PRACTICAL COMPONENT OF ZOO-III-E-2: DURATION - 02 HRS /WEEK
BASIC MICROBIOLOGY & FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY**

SR. NO	PRACTICAL	NO. OF PRACTICALS
1)	Preparation of culture media for bacteria (Plates, Slants, deeps, Broth).	02
2)	Staining of Microorganisms (Gram staining, negative staining).	02
3)	Isolation of pure colonies of Bacteria (streak plate method – 3 Quadrant And 5 Quadrant methods)	02
4)	Identification of Products of metabolic pathways of microbial cells.	01
5)	Bacteriological testing of Milk.	01
6)	DNA sequencing - Analysis of prints.	01
7)	Isolation of Plasmid DNA (Demonstration)	02
8)	Transformation of bacteria (Selection by blue-white colony method – demonstration practical	02

REFERENCE BOOKS:

Essential books:

- 1) Pelczar MJ, Chan ECS, Krieg NR(2009). *Microbiology*. Tata Mc Graw Hill, New York.
- 2) Dubey RC and Maheshwari DK (2012). *A test book of Microbiology*. S Chand Publishers, New Delhi.
- 3) Prave P, Faust U, Sittig W and Sukatsh DA(2004). *Fundamentals of Biotechnology*.
- 4) Purohit SS(2008). *Biotechnology Fundamentals and applications*. Agrobios, Jodhpur India.
- 5) Ranga MM(2012): *Animal Biotechnology*. Agrobios, Jodhpur India.

Supplementary reading:

- 6) Black JG(2005). *Microbiology principles and explorations*. John Wiley and sons Inc.
- 7) Sullia SB and Shantharam S(2006). *General Microbiology*. Oxford and IBH Publishing Co Pvt Ltd, NewDelhi.

REFERENCE BOOKS FOR PRACTICALS:

- 1) Gunasekaran P(2009). *Lab Manual in Microbiology*. New Age International Ltd. Publishers, New Delhi.

ELECTIVE COURSE: ENVIRONMENTAL TOXICOLOGY

COURSE CODE:	ZOO-III-E-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To study the different environmental pollutants and their toxicity.• To know the physiological effects of toxicant exposure.
LEARNING OUTCOME:	After completion of the course students are expected to be able to: <ul style="list-style-type: none">• Distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties.• Identify the main sources and types of environmental pollutants and assess their potential environmental fate.• Will learn mechanisms of detoxification of various varieties of toxicants.• Will learn bio-indicators of exposure to specific environmental contaminants.• Identify potential solutions to anthropogenic pollution

ZOO-III-E-3: ENVIRONMENTAL TOXICOLOGY

MODULE	TOPIC	CONTACT HOURS
MODULE 1: INTRODUCTION TO TOXICOLOGY	<p>1.1 Introduction To Toxicology:</p> <ul style="list-style-type: none"> ○ Definition and History of Toxicology and Toxicity ○ Disciplines of Toxicology ○ Biouptake, Bioaccumulation, Biotransfer and Biological Magnification, Relationship to Other Sciences, Scope and importance of Toxicology <p>1.2: Classes Of Toxicant:</p> <ul style="list-style-type: none"> • Define Toxicant and Toxins, their classification • Toxicants in Air, Water and Soil • Toxicants in Domestic and Occupational Settings • Synthetic drugs: Solvents; Therapeutic drugs, Drugs of abuse, Combustion products, Cosmetics • Movement and fate of Toxicants in the environment 	15
MODULE 2: ENVIRONMENTAL IMPACT MITIGATION	<p>2.1: Toxicity Of Heavy Metals:</p> <ul style="list-style-type: none"> • Toxicity of Arsenic, Lead, Mercury, • Cadmium, Copper, Zinc, Aluminium, Iron and Manganese; Sources and portals of heavy metal pollutants; Toxicity of substances on Human and Animals <p>2.2: Agro-Chemical Pesticides And Their Environmental Impact Mitigation</p> <ul style="list-style-type: none"> • Definition and Classification • Organochlorine Insecticides, Organophosphate Insecticides, Carbamates, Pyrethroid Insecticides, Dinitrophenols, Herbicides, Fungicide • Control of Pesticide Pollution; Integrated Pest management 	15
MODULE 3: TOXINS AND FOOD ADDITIVES	<p>3.1: Toxins:</p> <ul style="list-style-type: none"> • History, Classes of Toxicants: Microbial, Mycotoxins, Algaltoxins, Planttoxins, Animaltoxins, <p>3.2: Food Additives:</p> <ul style="list-style-type: none"> • General account of Food Additives: • Incidental or Indirect additives • Intentional or Direct additives: a. Antioxidants b. Emulsifiers c. Enzymes d. Flavouring agents e. Colour and preservatives f. Artificial sweetening agents i) Saccharine ii) Urea derivatives 	15

PRACTICAL COMPONENT OF ZOO-III.E-3:ENVIRONMENTAL TOXICOLOGY (DURATION-02 HRS/WEEK)		
Sr.No.	Practical	No.of Practicals
1.	To determine the effect of temperature on the toxicity of a pollutant	01
2.	To determine the effect of pH on the toxicity of a pollutant.	01
3.	To Separate and analyse the residues of carbamate pesticides by thin layer chromatography.	01
4.	To evaluate qualitatively the presence of pesticide residues in vegetable samples.	01
5.	Estimation of total dissolved solids in given water sample.	01
6.	To determine Lc ⁵⁰ of a pollutant on mosquito larvae .	02
7.	Effect of pesticides on Oxygen consumption in fish	01
8.	Estimation of Phosphorus in given water sample by Spectrophotometer	01
9.	Estimation of Boron from given water/soil sample by spectrophotometer	01
10.	Estimation of Primary Productivity by Light and Dark bottle method.	02
11.	Estimation of Fluorides in given water sample	01
12.	Determination of Nitrates from given water sample.	01

REFERENCE BOOKS FOR THEORY:

1. Ernst Hodgson(2004) A Text Book of Modern Toxicology ,A John Wiley and sons Inc,Publication.
2. Gupta P.K.(2010) Modern Toxicology, Pharma Med Press, Hyderabad.
3. Omkar(2007) Concepts of Toxicology ,Vishal Publishing Co, Jalandhar
4. Pandey K,Shukla J.P. and Trivedi S.P. (2011)Fundamentals of Toxicology,New Central Book Agency(P) Ltd.
5. P.D.Sharma (2011)Environmental Biology and Toxicology (Third edition),Rastogi Publications,Meerut-250002.

REFERENCE BOOKS FOR PRACTICALS:

1. Adam Wooley (2008) A Guide to Practical Toxicology:Evaluation,Prediction,and Risk IIInd Edition,Informa Healthcare U.S.A.,Inc. New York.
2. Rao K.S. (1998) Practical Ecology,Anmol Publications Pvt. Ltd. New Delhi.

ELECTIVE COURSE: PARASITOLOGY

PAPER CODE:	ZOO-III.E-4
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To be familiar with the parasite host interactions.• To gain knowledge on diagnosis of parasite infections and also to learn about the preventive measures.
LEARNING OUTCOME:	At the end of the course the learner will be acquainted with dimensions of public health viz a viz parasitic diversity, epidemiology and community prophylaxis

ZOO-III.E-4: PARASITOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Basic Principles of Parasitology and parasitic protozoans	1.1 Parasite systematics, Ecology and Evolution 1.2 Immunology and Pathology 1.3 Symbiosis and parasitism 1.4 Parasite host interactions Form, function, classification, life cycle, diagnosis and preventive measures 1.5 <i>Trypanosomagambiens</i> 1.6 Amoebas - <i>Entamoebahistolytica</i> 1.7 Malaria organisms - <i>Plasmodium vivax</i> 1.8 Sexually transmitted parasite - <i>Trichomonasvaginalis</i>	15
MODULE 2: Parasitic Platyhelminthes and Nematodes	Form, function, classification, life cycle, diagnosis and preventive measures 2.1 Trematoda(liver fluke - <i>Fasciola hepatica</i> , intestinal fluke - <i>Fasciolopsisbuski</i> , lung fluke - <i>Paragonimuswestermani</i>); 2.2 Cestoda (Tape worm - <i>Taeniasolium</i>) 2.3 Hook worms- <i>Ancylostoma duodena</i> 2.4Guinea worm- <i>Dracanculusmedinensis</i> 2.5Round worm <i>Ascarislumbricoids</i> , <i>Enterobiasvermicularis</i> 2.6 <i>Wuchereriabancrofti</i>	15
MODULE 3: Parasitic arthropods and Parasites of domestic livestock	Form, function, classification , life cycle, diagnosis and preventive measures: Copepods, Barnacles, Amphipods, Isopods, Flea, Ticks, Mites, Head and pubic lice	15

**PRACTICAL COMPONENT OF ZOO-III.E-4: PARASITOLOGY
(DURATION -02 HRS /WEEK)**

Sr. No	Practical	No. of Practicals
1)	Study of <i>Trypanosoma gambiense</i> , <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> , <i>Trichomonas vaginalis</i> , <i>Fasciola hepatica</i> , <i>Taenia solium</i> , <i>Ancylostoma duodenale</i> , <i>Dracunculus medinensis</i> , <i>Ascaris lumbricoides</i> , <i>Wuchereria bancrofti</i> , copepod, barnacle, amphipod, isopod from permanent slides with respect to parasitic adaptations.	06
2)	Preparation of peripheral blood smear from the perspective of detection of haemoparasites	01
3)	Study of parasites of domestic livestock (parasite, pathogenicity)	04
4)	Study of fish parasites	01

REFERENCE BOOKS:

1. Chatterjee, K.D. (2009) Parasitology (Protozoology and Helminthology) with two hundred fourteen illustrations. CBS, 13th edition.
2. Dey, N.C., Dey, T.K. and D.M. Sinha (1995) Medical Parasitology. New Central book agency private limited, Calcutta.
3. Paniker, J.C.K. (2007) Textbook of medical parasitology. Jaypee Brothers, New Delhi.
4. Schmidt, G.D. (1990) Essentials of Parasitology. Universal Book Stall, New Delhi.

REFERENCE BOOK FOR PRACTICALS:

1. Halton, D.W., Behnke, J.M. and I. Marshall (2005) Practical exercises in parasitology. Cambridge University Press.

SEMESTER – V

ELECTIVE COURSE: MOLECULAR GENETICS AND FORENSIC SCIENCE	
COURSE CODE	ZOO-V.E-9
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	This course will elucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose students to the basics of forensic science and understand diagnostic genetics.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to understand: <ul style="list-style-type: none">▪ The process of replication, transcription and translation▪ Difference between the gene expression in prokaryotes and eukaryotes▪ Branches of forensic science▪ The molecular tools used in genetic diagnosis

ZOO-V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Gene Expression and Gene Regulation	1.1 : DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication	2
	1.2: Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors	5
	1.3 : Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and eukaryotic translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA	4
	1.4: Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing	4
MODULE 2 : Basics of Forensic Science	2.1 : Definition, overview of Disciplines of Forensic science	3
	2.2: Crime and Crime Scene management: Types of crime scenes – indoor and outdoor. Securing and isolating the crime scene. Crime scene search methods. Safety measures at crime scenes. Legal considerations at crime scenes. Documentation of crime scenes – photography, videography, sketching and recording notes.	6
MODULE 3 : Diagnostic Genetics	2.3: Forms of forensic evidences: -Biological evidence: Bloodstains, hair, semen, DNA -Physical and trace evidence –pattern of blood stains, fingerprints, fibres, weapons - Documents- types of forensic documents (genuine /forged), methods of detecting forged documents(handwriting analysis, Analysis of paper and inks)	6
	3.1 : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening	5
	3.2: Cytogenetics/ Molecular Cytogenetics/ Molecular methods of detecting genetic disorders – Prenatal and Preimplantation screening	4
	3.3: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification	4

**PRACTICAL COMPONENT OF ZOO-V.E-9: MOLECULAR GENETICS AND
FORENSIC SCIENCE
(DURATION -02 HRS /WEEK)**

SR.NO.	PRACTICAL	NO. OF PRACTICALS
1	Isolation of DNA from peripheral blood/tissue (chick liver).	01
2	Microscopic examination of Hair a. Human scalp Hair b. Animal Hair	02
3	Sketching and Photography of various type of crime scene.	02
4	Presumptive Tests for Blood a. Phenolphthalin Assay b. Benzidine c. Leucomalachite Green (L.M.G.) d. Luminol Test	02
5	Examination of ink by TLC method	01
6	To perform ridge tracings and ridge counting	01
7	Analysis of DNA fingerprints	03

REFERENCE BOOKS :

- 1) J. Prahlow (2010); *Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists*, DOI 10.1007/978-1-59745-404-9_2, C Springer Science + Business Media, LLC (Ebook available)
- 2) Robert Schleif (1993). *Genetics and Molecular Biology. S E C O N D E D I T I O N.* Department of Biology, The Johns Hopkins University, Baltimore, Maryland. The Johns Hopkins University Press 2715 North Charles Street Baltimore, Maryland 21218-4319, The Johns Hopkins Press Ltd., London (Ebook available)
- 3) Richard Saferstein (2011); *Forensic Science, II Edition*, Prentice Hall publishers, Sanfrancisco
- 4) Griffith A, Wessler S, Lewontin R Gelbart W, Suzuki D and Miller J(2000). *Introduction to Genetic Analysis. Eighth Edition.* (Ebook available)
- 5) Tom Strachan and Read A (2010); *Human Molecular Genetics. Fourth Edition.* Garland Science Publisher, New York, NY 10017

REFERENCES BOOKS FOR PRACTICALS:

- 1) Hikmet Geckil (). *Molecular Biology Lab manual. UMBC.* (Ebook available).
- 2) J. Prahlow (2010); *Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists*, DOI 10.1007/978-1-59745-404-9_2, C Springer Science+Business Media, LLC (Ebook available.)

ELECTIVE COURSE: ECONOMIC ZOOLOGY

COURSE CODE	ZOO-V.E-10
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	To study the various aspects of economic zoology To study the species of economic importance, classification To gain an insight whether own business can be started based on studying the zoological species and their products
LEARNING OUTCOME	How zoological species contribute to economic sources can be learned. Students will learn the techniques of rearing and maintenance of the species, harvesting their products and selling of species and the products

ZOO-V.E- 10 : ECONOMIC ZOOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Scope of Economic Zoology	1.1 : Economic Zoology, History, Scope,	3
	1.2 : Species of bionomic importance (Honey bee, Silkworm, lac insect, mackerel, domestic fowl, goat, sheep, cow, buffalo, pig, rats, mice)	3
	1.3 : Source, properties, constituents and nutritive value of products of bionomic importance: eggs of poultry, milk, meat, honey, medicinal value of synthetic insulin (recombinant), significance of wool, silk, lac	5
	1.4 : Organizations and their functions: agricultural and processed food products export development authority (APEDA), the marine products exports developmental authority (MPEDA), central silk board (CSB), central bee research and training institute (CBRTI), pharmaceutical and biotechnology industries (Lupin) and contract research organizations (Intox), and research institutes (NIN, Hyderabad)	4
MODULE 2 : Models in Economic Zoology	2.1 : Insects, products and applications : lac insects, honey bees, silkworms	3
	2.2 : Vermiculture: Rearing and maintenance of earthworms	2
	2.3 : Aquaculture : rearing and maintenance of prawns, oysters, edible and ornamental fishes	3
	2.4 : Poultry : rearing and maintenance of domestic fowl, applications and products	3
	2.5 : Business models of apiculture, sericulture, aquaculture and poultry	4
MODULE 3 : Pharma products and biological control	3.1 : Pharmaceuticals from animals and their Applications (antiserum), from transgenic animals (malaria vaccine, alpha 1 antitrypsin, lactoferrin, fibrinogen)	5
	3.2 : Species used in biological control : <i>Casnoidea indica</i> , <i>Trichogramma</i> , <i>Poecilia reticulata</i> / <i>Gambusia affinis</i>	5
	3.3 : Maintenance and breeding of animals for research: mice, rats, guinea pigs, rabbits, marmosets, guidelines given by committee for the purpose of control and supervision of experiments on animals (CPCSEA)	5

PRACTICAL COMPONENT OF ZOO-V.E-10 (DURATION - 02 HRS /WEEK)		
SR.N O.	PRACTICAL	NO. OF PRACTICALS
1	Vermicomposting	05
2	Preparation of dairy products from milk : cheese and butter	02
3	Laboratory observations of insects – Honeybee, Silk moth, Lac insect	01
4	Visit to dairy industry/poultry/ piggery/apiary/silk industry/ biotechnology industry/pharmaceutical industry/research institute	04

REFERENCE BOOKS :

- 1) G. S. Shukla, V. B. Upadhyay (2008) *Economic Zoology*, Rastogi Publications, Meerut
- 2) H. Osborn (1908) *Economic Zoology an introductory text book in zoology with special reference to its applications in agriculture, commerce and medicine* The Macmillan Company
- 3) K. P. Shrivastava, Gs Dhaliwal (2015) *Text Book of Applied Entomology* Kalyani Publishers
- 4) P. K. Gupta (2011) *Vermicomposting for Sustainable Agriculture*, Agrobios India Ltd
- 5) S. Singh (1962) *Bee-Keeping in India* ICAR New Delhi p. 214

REFERENCE BOOKS FOR PRACTICALS:

- 1) A. K. Tripathi(2009) *Mulberry Sericulture: Problems And Prospects* Aph Publishing Corporation
- 2) C.L. Metcalf and W.P Flint (1962) *Destructive and Useful Insects* New York, N.Y. : McGraw-Hill

ELECTIVE COURSE: ECOLOGY AND ETHOLOGY

COURSE CODE	ZOO-V.E-11
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	<ul style="list-style-type: none">• To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components• To study impact of anthropogenic activities on ecosystem and study behaviour of organisms under natural conditions
LEARNING OUTCOME	<ul style="list-style-type: none">• The student will gain better understanding in ecology and ethology• This course also has applied value towards conservation of biodiversity and sustainable development

ZOO-V.E- 11 : ECOLOGY AND ETHOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1 : Basic Ecology	1.1 :Introduction to Ecology : What is Ecology? History of ecology, ecology today, scope of ecology, objective of study,subdivisions of ecology	03
	1.2 : Ecosystem Ecology:kinds of ecosystem (marine, fresh water, terrestrial),Gaia hypothesis, deep ecology, energy flow within the Ecosystem,food chains and energy flow,ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead.	06
	1.3: Population Ecology:population density,natality, mortality,survivorship curve and life tables,age distribution,biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity,predator –prey relationships,symbiosis	06
MODULE 2 : Conservation Ecology and Basic Ethology	2.1: Community Ecology:characters of a community, classification of a community,community periodism, community stratification,community succession	03
	2.2: Biodiversity and conservation: application of ecology in biodiversity conservation	04
	2.3:Introduction to Ethology: the history of ethology,approaches to study of behavior, types of behavior – instinct and learning,economic and social aspect of behaviour, ethologists and their work – Lorenz, Tinbergen, Goodall, M.K. Chandrashekar, animal behaviour :an evolutionary approach	04
	2.4: Concept of Ethology:stimulus –response concept,reflexes, innate releasing mechanisms,fixed action pattern,ethogram releaser,motivation or drive with respect to hunger and sexual behaviour	04
MODULE 3 : Advanced Ethology	3.1 : Approaches to studying behaviour, methods associated with neurophysiological approach,psychological and ethological approach.	03
	3.2: Pheromones :introduction,types of pheromones,the primer pheromones,the imprinting pheromones	03
	3.3:Hormones: effect of hormones on sexual behaviour,maternal behaviour,territorial marking, learning and memory	03
	3.4:Patterns of behavior :feeding, aggressive and reproductive behavior, biological clocks	03
	3.5:Communication behavior :introduction,communication signals,communication among bees: Honeybee dances	03

PRACTICAL COMPONENT OF ZOO-V.E-11: ECOLOGY AND ETHOLOGY (DURATION -02 HRS /WEEK)		
SR.NO.	PRACTICAL	NO. OF PRACTICALS
1	Determination of population density in a natural/hypothetical community by Quadrats method and calculation of Shannon-Weiner diversity Index for the same community	02
2	Study of an aquatic/mangrove ecosystem: Measurement of the area, temperature, turbidity, determination of pH, and dissolved oxygen content (Winkler's method), and free CO ₂	04
3	To study the habituation to light stimulus in earthworm/crabs/snails/ spider web	01
4	To demonstrate phototactic and geotactic responses of the animal provided earthworm/crabs	01
5	Study of Life Tables and plotting of survivorship curves of different types from the hypothetical/real data provided.	01
6	Report on a visit to National Parks/Biodiversity Parks/Wild life sanctuary	03

REFERENCE BOOKS :

1. Arora, Mohan. P. (2004) : *Ecology* , Himalaya Publishing House
2. Aubrey Manning and stamp Dawkins (1997) : *An Introduction to Animal behaviour (fourth edition)*, Cambridge University Press.
3. Dash M. C. (2001) : *Fundamental of Ecology* , Tata Mc Graw – Hill publishing Company Limited New Delhi
4. Felicity Huntingford (1984) : *The study of Animal behaviour* , Chapman and Hall.
5. Hoshang S. Gundevia and Hare Govind Singh (2006) : *A Text Book of Animal Behaviour*, S. Chand & Company LTD. New Delhi-110055.
6. Juneja Kavita (2002) : *Ecology* , Anmol Publications PVT. LTD. New Delhi-110002 (India)
7. Mathur Reena (1994) : *Animal Behaviour*, Rastogi and Company, Meerut-250002 India.
8. Rana, S. V. S.(2003) : *Essentials of Ecology and Environmental Science* ,Prentice- Hall of India Private Limited , New Delhi-110001
9. Ranga, M. M.(2002) : *Animal Behaviour Second Enlarged Edition* , Agrobios (India)
10. Robert A. Wallace (1938) : *Animal Behaviour Its Development, Ecology and Evolution* , Goodyear Publishing Company, Inc. Santa Monica, California.
11. Sharma P.D.(2014-15) : *Ecology and Environment*, Rastogi Publications. Meerut (12th revised edition) -25002.
12. W.H. Thorpe (1979) : *The Origins and rise of Ethology*, Praeger Publishers.

**ELECTIVE COURSE:
FISH PRESERVATION AND PROCESSING**

COURSE CODE	ZOO-V.E-12
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	<ul style="list-style-type: none"> • To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
LEARNING OUTCOME	By the end of the course, the students will be familiar with the economic benefits of fishes. They will also be able to understand the nutritional values of the fishes and to identify some of the fish pathogens

ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Fishery Development	1.1 : Status of Development of the fishery and seafood processing industry.	05
	1.2: Empowerment through Aquatic Products: (Background, Nutritional security, Role of Fisheries Sector, Role of Tifac in Fisheries Sector, Objectives, Integrated Fisheries Project (IFP), Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY)	10
MODULE 2: Fish Handling and preservation	2.1: Recent Scenario: Quality Changes and Shelf life of Chilled Fish, The effect of Hygiene during handling	04
	2.2: Fish Handling Methods: Organoleptic test, Assessment of Fish Quality, Quality assessment of Fresh Fish, Quality Assessment of Fish Products, Physical methods, Assurance of Fresh Fish Quality, Post harvest Changes in Fish, How does a Fish Lose its Quality, fish as vectors of zoonotic diseases	08
	2.3: Fish Preservation: Reasons for Spoilage of Fishes, Methods of Fish.	03
MODULE 3: Value of Fish	3.1: Economic Importance of Fish: Food value, Fish By-Products, surimi, Goan fish para, balchao	05
	3.2: Postmortem changes in Fish, Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition, Lipids, Proteins, N- containing Extractives, Vitamins and Minerals,	05
	3.3: Aquatic Resources and their utilization, value added product: chitin	05

PRACTICAL COMPONENT OF ZOO-V.E-12: FISH PRESERVATION AND PROCESSING (DURATION -02 HRS /WEEK)		
SR.NO.	PRACTICAL	NO. OF PRACTICALS
1	Estimation of Proteins and Lipids form fish tissue	02
2	Determination of moisture and ash content from the fish	01
3	Preparation of fish Fillet	01
4	Study of Fish Parasites – ectoparasites (gills); endoparasites (gut)	02
5	Method of fish preservation (salting, pickling)	02
6	Visit to Fish Processing Centre/Fishing Co-operative Society /Fishery Institute/Fishery survey of India, Vasco (FSI)	04

REFERENCE BOOKS :

- 1) *Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers
Delhi,India*
- 2) *Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India*

REFERENCE BOOKS FOR PRACTICALS:

- 1) *Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers
Delhi,India*
- 2) *Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India*

EVEN SEMESTER

SEMESTER – IV

ELECTIVE COURSE: ANIMAL CELL CULTURE AND APPLICATIONS	
COURSE CODE:	ZOO-IV-E-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is an introduction to the theory, standard practices, and methodologies of animal cell culture. The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance of cell lines.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">▪ operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory;▪ Prepare and sterilize media and solutions used in cell culture.▪ Demonstrate an understanding of the concepts and applications of mammalian cell culture.▪ Recognize and employ biosafety guidelines and practices.

ZOO-IV-E-5: ANIMAL CELL CULTURE AND APPLICATIONS

MODULE	TOPICS	CONTACT HOURS
MODULE 1: LAB REQUIREMENTS FOR CELL CULTURE (15 hrs)	1: Historical background of Cell culture:	01
	2: Biology of cells in culture: Origin and characteristics, Differentiation, kinetics of cell growth, Genetics of Cultured cells, Problems associated with cell culture	04
	3: Lab requirements for animal cell culture: <ul style="list-style-type: none"> ○ Lab facilities and setup for cell culture ○ Major and minor equipments ○ Environmental conditions ○ Substrates for Culturing and sub culturing 	05
	4: Animal tissue culture media <ul style="list-style-type: none"> ○ Natural media – biological fluids, tissue extracts ○ Chemically defined media- characteristic and composition ○ Media supplements – L Glutamine, serum. Advantages and disadvantages of serum in media / serum free media 	05
MODULE 2: CELL CULTURE TECHNIQUES(15 hrs)	5: Primary cell culture: <ul style="list-style-type: none"> ○ Mechanical disaggregation ○ Enzymatic disaggregation ○ Protocol for primary cell culture 	06
	6: Secondary cell culture/ Sub culturing: <ul style="list-style-type: none"> ○ Protocol for sub culturing of suspension culture ○ Protocol for sub culturing of adherent ○ Established cell lines 	06
	7: Scale up of animal cell culture: <ul style="list-style-type: none"> ○ Techniques of Scale up of suspension cultures ○ Techniques of Scale up of Monolayer cultures 	03
MODULE 3: CELL CULTURE APPLICATIONS(15 hrs)	8: Cell Hybridoma Technology : <ul style="list-style-type: none"> ○ Steps of cell Hybridoma technology ○ Procedure ○ Production of monoclonal antibodies ○ Applications of monoclonal antibodies 	05
	9: Valuable Products through cultured cells: Production of Tissue plasminogen, growth factor, Erythropoietin, Factor VIII, Interferons.	05
	10: Other Application: Vaccines through cultured cells, Cytotoxicity testing, Fluorescent In-Situ Hybridization for disease detection, Cell culture in biomedical research.	05

PRACTICAL COMPONENT OF ZOO-IV-E-5: DURATION -02 HRS /WEEK ANIMAL CELL CULTURE AND APPLICATIONS		
Sr. No	Practical	No. of Practicals
4)	Packing and sterilization of glass and plastic wares for cell culture & Lab Precautions and Biosafety measures	02
5)	Preparation of reagents and media for cell culture. ▪ Reagents ▪ Media / Buffers	02
6)	Quantification of cells (Viable cell count) by trypan blue exclusion dye.	01
7)	Methods used for cell disaggregation – Mechanical and Enzymatic	02
8)	Setting up of primary cell culture ▪ Suspension culture ▪ Adherent cell culture	02
9)	Setting up of chicken embryo fibroblast culture (cold trypsinization / warm trypsinisation)	02
10)	Biological waste disposal methods	01

REFERENCE BOOKS:

- 1) *Ranga MM(2012). Animal Biotechnology. Agrobios India Ltd. Jodhpur.*
- 2) *Mathur S(2006). Animal Cell and Tissue Culture. Agrobios India Ltd. Jodhpur.*
- 3) *Masters W(2005). Animal Cell Culture. Oxford University Press Inc., NewYork*
- 4) *Gangal S(2010). Principles and practices of Animal Tissue Culture. Second Edition. University Press PVT. LTD., Hyderabad India.*
- 5) *Freshney I R(2007). Culture of animal Cells: A manual of Basic Techniques. 5th edition, John Wiley & Sons Inc Pte Ltd*

REFERENCE BOOKS FOR PRACTICALS:

- 1) *E Book- Fletcher L, Goss E. Phelps P and Wheeler A(2014). Introduction to Biotechnology – Laboratory Manual.*
- 2) *Harisson M A and Rae IF(1997):General Techniques of Cell Culture Handbook in Practical animal cell biology. Cambridge University Press.*
- 3) *Ebook- Cell Culture basics. From www.invitrogen.com/cellculture_basics.*

ELECTIVE COURSE : AQUACULTURE AND FISHERIES

COURSE CODE:	ZOO-IV.E-6
MARKS:	100[75- Theory; 25- Practicals]
CREDITS:	04 [03-Theory;01- Practical)
CONTACT HOURS	: Theory :45 Hours(03 LEC/WEEK) Practicals: 30 Hours(01 PRACTICAL/WEEK)
COURSE OBJECTIVES:	<ul style="list-style-type: none">• To improve the understanding of conservation and sustainability of living resources• To improve the social and economic benefits derived from aquaculture and fisheries.• To study the role of aquaculture in rural development in solving nutritional security and unemployment.• Empowerment of fishery and entrepreneurship development
LEARNING OUTCOMES:	<ul style="list-style-type: none">• The student may become future aqua culturist, entrepreneur who will provide employment to others.• Optimum utilization of unutilized and underutilized aquatic resources for fisheries and aquaculture, enhance the fish production, employment generation and even to earn the foreign exchange.

ZOO-IV.E-6: AQUACULTURE AND FISHERIES

MODULE	TOPIC	CONTACT HOURS
MODULE 1:	<p>1.1: Inland Fisheries:</p> <ul style="list-style-type: none"> • fisheries: Fisheries of Ganga and Brahmaputra river system • Reservoir fisheries • Lakesterine fisheries: Cat fish, Murrels, Mulletts, Major carps • Cold water fisheries: Mahaseer fishery <p>1.2: Marine Fisheries:</p> <ul style="list-style-type: none"> • Estuarine fisheries: The catadromous fishes (<i>Polynemous indicus</i>, <i>P.tetradactylus</i>) and anadromous fishes (<i>Hilsa ilisha</i>, <i>Pama pama</i>, <i>Polynemous paradiseus</i>) • Coastal fisheries or Inshore fisheries: Elasmobranch fishery and Teleost fishery • Offshore and Deep sea fisheries: Pomfrets (<i>Pampus</i>, <i>Stromateus</i>) <i>Eleutheronema tetradactylus</i> (rava), <i>Polydactylus indicus</i> (dara), ghol (<i>Pseudosciaena diacanthus</i>), scianids (Kurtus) <p>1.3: Crustacean And Molluscan Fisheries:</p> <ul style="list-style-type: none"> • Prawn fisheries in Goa: Penaeid and Palaemonid groups. • Crab fisheries in Goa • Edible oyster fisheries in Goa • Mussel fisheries in Goa <p>1.4 :Fishing Methods In India:</p> <ul style="list-style-type: none"> • Marine Fishing Crafts and Gears used in Goa • Inland Fishing Crafts and Gears used in Goa 	15
MODULE 2:	<p>2.1: Integrated Fish Farming Systems:</p> <ul style="list-style-type: none"> • Principle of integrated Fish farming • Integration with animal husbandry • Integration with farming systems. <p>2.2: Induced Breeding:</p> <ul style="list-style-type: none"> • Selection of site • Design and Layout of fish farm • Freshwater and brackish water pond construction • Pond maintenance • Prevention of fish diseases • Control of aquatic weeds • Control of predatory and Weed fishes • Control of Aquatic insect • Harvesting 	15

MODULE 3:	<p>3.1: Fish Culture System:</p> <ul style="list-style-type: none"> • Mono culture, polyculture, composite culture, raceway culture, extensive, semi intensive, intensive, zero water exchange • Objective of fish culture • Pond preparation • Selection of species • Stocking of seed • Feed and feeding • Harvesting • Bionomics of fish culture <p>3.2: Cage And Pen Culture:</p> <ul style="list-style-type: none"> • Advantage of Fish culture in cages • Selection of species for cage culture • Installation of cage - shape ,size and types of cages • Pen culture • Maintenance of cage and pen <p>3.3: Preservation And Processing:</p> <ul style="list-style-type: none"> • Fish marketing • Transportation • Reasons for spoilage of Fishes • Methods of fish preservation-Freeze-drying, • Salting, Refrigeration, Deep Freezing, 	15
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PRACTICAL COMPONENT OF ZOO-IV.E-6: AQUACULTURE AND FISHERIES (DURATION – 02 HRS/ WEEK)		
Sr. No.	Practical	No. of Practicals
1.	Morphometric and Meristic study : a key for fish Identification	03
2.	Identification of important edible shrimps and crabs(any two)	01
3.	Identification of important Freshwater and Marine edible fishes (five fishes each from different families)	02
4.	Methods of Measuring gonosomatic index of Fish	01
5.	Estimation of Fecundity by Frequency Polygon method from a Marine Fish	01
6.	Food and Feeding of Fish by analysis of gut content	01
7.	Visit to a Fish Landing Center to study different Types of Gear and Craft	01
8.	Visit to Fish breeding Center to study Induced Breeding in Indian Carps	01
9.	Visit to ICAR/NIMR(National Institute of Malaria Research) Old Goa for Study of Aquarium and Larvivorous Fishes	01

REFERENCE BOOKS FOR THEORY:

1. Bal D.V., Rao Virbhadra, K (1984) Marine Fisheries, Tata McGraw- Hill Publishing Company Ltd. New Delhi.
2. Cushing D.H. (1975) Marine Ecology and Fisheries, Cambridge University Press.
3. Day, F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2 Vols., Taylor and Francis London.
4. Khanna S.S. (1984) An Introduction to Fishes, Central Book Depot Allahabad.
5. Pandey K and Shukla J.P. (2015) Fish and Fisheries. Rastogi Publications Meerut-250002
6. Sakhare B. Viswas (2007) Applied Fisheries. Daya Publishing House Delhi-110035
7. Santhanam R (1990) Fisheries Science, Daya Publishing House Delhi.
8. Santhanam R, Ramanathan N and Jagatheesan G (1990) Coastal Aquaculture in India, CBS Publishers and distributors, Delhi.
9. Shrivastava C.B.L. (1996) A Text Book of Fishery Science and Indian Fisheries. Kitab Mahal 22 A, S.N. Marg, Allahabad.
10. Singh B.K. (2008) Applied Fisheries and Aquaculture. Swastik Publishers and distributors, Delhi.

REFERENCE BOOKS FOR PRACTICALS:

1. Chandy. M (1970) Fishes, National Book Trust, India, New Delhi.
2. Day. F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2 Vols., Taylor and Francis London.
3. R.J. Ranjit Daniels (2002) Freshwater Fishes of Peninsular India, Universities Press (India) Pvt. Ltd. Hyderabad.
4. Sakhare Viswas B. (2007) Applied Fisheries, Daya Publishing House Delhi.
5. Sharma U and S.P. Grover (1982) An Introduction to Indian Fisheries, Dehradun India.
6. Srivasava C.B.L. (1986) A Text Book of Fishery Science and Indian Fisheries, Kitab Mahal Allahabad.

ELECTIVE COURSE: IMMUNOLOGY

COURSE CODE:	ZOO-IV.E-7
MARKS:	100 [75 -Theory ; 25- Practicals]
CREDITS:	04 [03 -Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	Familiarize students and make them learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.
LEARNING OUTCOME:	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">• Understand the components of the immune system and their function.• Be able to explain the mechanisms of immune response.• Perform immunoassays to detect the presence of antigens or antibodies(disease detection).

ZOO-IV-E-7: IMMUNOLOGY

MODUL E	TOPICS	CONTAC T HOURS
MODUL E 1: INTROD UCTION TO IMMUN OLOGY	1: OVERVIEW OF IMMUNE SYSTEM: <ul style="list-style-type: none"> • Basic concepts in immunology • Components of the immune system 	05
	2: INNATE AND ADAPTIVE IMMUNITY. <ul style="list-style-type: none"> • Innate immunity-Anatomical barriers/ layers of defense, cells and molecules involved in innate immunity • Adaptive immunity-cell mediated and humoral immunity, passive immunity (artificial and natural), Active(artificial and natural), Immune dysfunction 	10
MODUL E 2: ANTIGE NS AND IMMUN OGLOB ULINS	3: ANTIGENS. <ul style="list-style-type: none"> • Antigenicity and immunogenicity, Immunogens, adjuvants and haptens • Factors influencing immunogenicity • B and T cell epitopes 	05
	4: IMMUNOGLOBULINS <ul style="list-style-type: none"> • Structure and function of different classes of Immunoglobulin. • Antigen-Antibody interactions • Immunoassays, monoclonal & polyclonal antibodies 	07
	5: MAJOR HISTOCOMPATIBILITY COMPLEX. <ul style="list-style-type: none"> • Structure and function of endogenous and exogenous pathways of antigen presentation 	03
MODUL E 3: IMMUNE RESPON SE	6: CYTOKINES AND COMPLEMENT SYSTEM <ul style="list-style-type: none"> • Properties and functions of cytokines, cytokine based therapies • Components and pathways of complement activation 	05
	7: HYPERSENSITIVITIES, AUTOIMMUNITY AND TRANSPLANTATION <ul style="list-style-type: none"> • Gell and coombs' classification, types of hypersensitivities(overview) • Autoimmune responses against self antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection, types and mechanisms of transplant rejection) 	07
	8: VACCINES <ul style="list-style-type: none"> • Types of vaccines -inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines 	03

PRACTICAL COMPONENT OF ZOO-IV-E-7: IMMUNOLOGY (DURATION -02 hrs/WEEK)		
Sr. No	Practical	No. of Practicals
1	Preparation of serum from goat blood.	02
2	Slide Agglutination Reaction(blood groups – A / AB / O with Rh)	02
3	Differential count of leukocytes	01
4	Detection of presence of antigen / antibody - Simple immunodiffusion	01
5	Antibody Titre determination - Ouchterlony immunodiffusion	02
5	Antigen –antibody reaction by immunoelectrophoresis	02
6	Elisa TEST- pregnancy test	01
7	Phagocytosis – WBC (demonstration)	01

REFERENCE BOOKS:

Essential books:

- 1) Abbas KA, Lechtman HA(2007). *Basic Immunology, Updated Edition 2006-2007: with STUDENT CONSULT. Access (Paperback).*
- 2) David M, Jonathan B, David RB and Ivan R(2006). *Immunology. VII Edition, Mosby, Elsevier Publication.*
- 3) Abbas KA, Lechtman HA(2003). *Cellular and Molecular Immunology. Saunders Publication.*
- 4) Kindt TJ, Goldsby RA, Osborne BA and Kuby J(2006). *Immunology. VI edition. W H Freeman and company.*

Ebooks:

- 5) Frank SA(2002). *Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.*
- 6) Zabriskie JB(2009). *Essential Clinical Immunology. Cambridge University Press.*

REFERENCE BOOKS FOR PRACTICALS:

- 1) Talwar GP and Gupta SK(2012). *A handbook of practical and Clinical Immunology, CBS publishers.*

ELECTIVE COURSE : EVOLUTIONARY BIOLOGY

COURSE CODE:	ZOO-IV.E-8
MARKS:	100 [75-Theory; 25 –Practicals]
CREDITS:	04[03 – Theory; 01 – Practical
CONTACT HOUR :	Theory : 45 Hours(03 Lec./Week) Practicals: 30 Hours(01Practical/Week)
COURSE OBJECTIVE:	<ul style="list-style-type: none">• The study aims to discover the history of life and the causes of the diversity and characteristics of organisms.• To show the important contributions of evolutionary biology to other biological disciplines such as medicine
LEARNING OUTCOME:	<ul style="list-style-type: none">• The study will give detail knowledge about many unsolved hypothetical issues to solve it.• The student will learn that evolution is not a speculation , but a thoroughly supported hypothesis that explains the process of evolution

ZOO-IV.E-8: EVOLUTIONARY BIOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1:	<p>1.1: EVOLUTIONARY BIOLOGY:AN OVERVIEW</p> <ul style="list-style-type: none"> • What Is Evolution, History Of Evolutionary Biology, Pre Darwinian, Darwin’s Evolutionary Theory, Evolutionary Theories After Darwin • Famous contributions to evolutionary Biology: CarlLinneaus,Lamarck,Malthus,Darwin,Thomas Huxley,R.A.Fisher,Haldane,sewall Wright, G.G.Simpson, Dobzanhasky,Ernst Mayr, M.Kimura. <p>1.2: THE NATURAL SELECTION:</p> <ul style="list-style-type: none"> • The Nature of Natural Selection • Postulates of natural selection • Evidences of Natural selection • Types of natural selection(Stabilizing,Directional and Disruptive selection) • Natural Selection in action(Darwin’s finches, Endler’s guppies examples) • Sexual Selection <p>1.3: RANDOM PROCESS IN EVOLUTION:</p> <ul style="list-style-type: none"> • mutation :types of mutation • genetic drift(bottle neck effect,founder’s effect) • gene flow(migration/emmigration) <p>1.4: SYNTHETIC THEORY OF EVOLUTION</p> <ul style="list-style-type: none"> • Neo-Darwinis 	20
MODULE 2:	<p>2.1: NON- DARWINISM</p> <ul style="list-style-type: none"> • Neutral theory of evolution • Molecular polymorphism-nucleic acids and proteins • Molecular clocks <p>2.2: SPECIATION</p> <ul style="list-style-type: none"> • different concepts of speciation • Concept Of Biological Speciation(Allopatric/Sympatric) • Consequence Of Speciation • Factors involved in Biological Speciation(pre and post- zygotic mechanisms) <p>2.3: POPULATION GENETICS</p> <ul style="list-style-type: none"> • Hardy-Weinberg’s Law(H-W) • Genes And Genotype Frequencies • Factors Affecting H-W <p>2.4:ADAPTATIONS :</p> <ul style="list-style-type: none"> • Definition and kinds of adaptations with some examples. • Pre , Post adaptations 	10

	<ul style="list-style-type: none"> • Coadaptations and Parallel adaptations 	
MODULE 3:	<p>3.1: PATTERNS OF EVOLUTION:</p> <ul style="list-style-type: none"> • Sequential and Convergent Evolution • Microevolution • Macroevolution(Adaptive radiation) • Megaevolution • Gradualism And Punctuated Equilibrium <p>3.2: EVOLUTION AND HUMAN HEALTH AND DISEASES</p> <ul style="list-style-type: none"> • Design defects • Defence mechanisms-Allergy,morning sickness • Evolution of antibiotic resistance • Evolution of behaviour,Anxiety,fear and depression. 	15

**PRACTICAL COMPONENT OF ZOO-IV.E-8: EVOLUTIONARY BIOLOGY
(DURATION -02 HRS/WEEK)**

Sr.No.	Practical	No.of Practicals
1.	Study of homology and analogy from suitable specimens	01
2	Serial homology	01
3	Variations are basis for evolution	01
4	To demonstrate the role of Natural Selection in Fixing Favoured Adaptation and Eliminating Maladaptation.	02
5	Problems based on Population Genetics (PTC /blood group)	04
6.	An exercise to illustrate the concepts of Genetic drift	02
7.	Vestigial organs or Vestiges in animals and humans.	01

REFERENCE BOOKS:

1. Bipin Kumar(2001) Organic Evolution; Campus Books International, New Delhi.
2. Charlotte J. Avers (1989)Process and pattern in Evolution ; New York Oxford University Press.
3. Douglas J. Futuyma(2013) Evolution IIIrd edition; Sinaue Associates,Inc.Publishers Sunderland , Massachusetts U.S.A.
4. E.Peter Volpe(1989) Understanding Evolution Vth edition Universal Book Stall.
5. S.Osawa ,T.Honjo(Eds.)(1991) Evolution of life,Springer-Verlag Tokyo .
6. Savage Jay M (1969) Evolution , Amerind Publishing Co-Pvt. Ltd. New Delhi.
7. Veer Bala Rastogi (2004) Organic Evolution ,Eleventh revised edition; Kedarnath Ramnath Delhi.
8. Pranab K. Banerjee (2011) Problems on Genetics,Molecular Genetics and Evolutionary Genetics, New Central Book Agency (P) Ltd. Delhi

SEMESTER – VI

ELECTIVE COURSE: HEALTH AND NUTRITION	
COURSE CODE	ZOO-VI-E-13
MARKS	100 [75 -Theory ; 25- Practical]
CREDITS	04 [03 -Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none">▪ Know about nutrients and their function▪ Understand nutritional biochemistry and role of lifestyle and food habits in causing diseases

ZOO-VI-E-13: HEALTH AND NUTRITION

MODULE	TOPICS	CONTACT HOURS
<p>MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION</p>	<p>UNIT 1: Overview of health and nutrition</p> <ul style="list-style-type: none"> • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy • Adequate, optimum and balanced diet • Malnutrition and health. <p>UNIT 2: Nutritional Biochemistry</p> <ul style="list-style-type: none"> • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties(overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties 	<p>15</p>
<p>MODULE 2: NUTRIENTS AND DIETARY PATTERN FOR HUMANS</p>	<p>UNIT 3: Functions of food components of food-nutrients</p> <ul style="list-style-type: none"> • Biochemical role and dietary sources of macro and micronutrients (carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine). • Changes of nutrient value during cooking of the following food groups: cereals, pulses and vegetables. Nutrient loss - dry, moist, frying and microwave cooking. <p>UNIT 4: Nutrition and dietetics</p> <ul style="list-style-type: none"> • Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition. 	<p>15</p>

<p>MODULE 3: DIET RELATED DISEASES</p>	<p>UNIT 5:Health and diseases</p> <ul style="list-style-type: none"> • Major nutritional deficiency diseases- protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. • Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. • Social health problems: smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS); • Common ailments- irritable bowel disease (IBD), constipation: causes and dietary management <p>UNIT 6: Food hygiene</p> <ul style="list-style-type: none"> • Potable water- sources and methods of purification at consumer level • Food and water borne infections: bacterial infection: cholera, typhoid, dysentery; viral infection: hepatitis, poliomyelitis, protozoan infection: Amoebiasis, Giardiasis; Parasitic infection: Taeniasis and Ascariasis their causative agent, symptoms, transmission and prevention. • Brief account of food spoilage: Causes and preventive measures 	<p>15</p>
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<p align="center">PRACTICAL COMPONENT OF 'HEALTH AND NUTRITION ZOO-VI-E-13: DURATION (30 HOURS – 02hrs/WEEK)</p>		
<p>SR. NO</p>	<p align="center">PRACTICAL</p>	<p>NO. OF PRACTICALS</p>
<p>11)</p>	<p>To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric</p>	<p>02</p>
<p>12)</p>	<p>To determine absorbed oil content in fried foods</p>	<p>02</p>
<p>13)</p>	<p>Estimation of lactose in milk</p>	<p>02</p>
<p>14)</p>	<p>Ascorbic acid estimation in food by titrimetry</p>	<p>01</p>
<p>15)</p>	<p>Estimation of calcium in foods by titrimetry</p>	<p>01</p>
<p>16)</p>	<p>Observation of any two grain pests</p>	<p>01</p>
<p>17)</p>	<p>Project based:</p> <ul style="list-style-type: none"> • Identify nutrient rich sources of foods, their seasonal availability and price • Study of nutrition labeling on selected foods 	<p>03</p>

REFERENCE BOOKS:

- 1) Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.
- 2) Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.
- 3) Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
- 4) Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- 5) Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
- 6) Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
- 7) Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.

ELECTIVE COURSE: BASIC AND APPLIED ENTOMOLOGY

COURSE CODE	ZOO-VI.E-14
MARKS	100 [75 -Theory; 25-Practical]
CREDITS	04 [03- Theory; 01- Practical]
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Practical: 30 HOURS [01 Practical Per Week]
COURSE OBJECTIVE	<ul style="list-style-type: none"> • To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
LEARNING OUTCOME	<ul style="list-style-type: none"> • The students will achieve entrepreneurial opportunities in entomology. • They will gain knowledge on bionomically important insects and their products, insect pests of public health and veterinary importance and their management.

ZOO-VI.E-14: BASIC AND APPLIED ENTOMOLOGY

MODULE	TOPIC	CONTACT HOURS
MODULE 1 Fundamentals of Entomology	Unit 1: Class Insecta: <ul style="list-style-type: none"> • Salient features • Classification of insects up to orders – an overview Unit 2: Morphological studies: <ul style="list-style-type: none"> • of antenna, • wings, • legs • Mouth parts Unit 3: Techniques: <ul style="list-style-type: none"> • Collection of insects • Preservation of insects 	15
MODULE 2 Bionomics and control of crop pests and medically important pests	Unit 4: Pest of agricultural importance: <ul style="list-style-type: none"> • Paddy pests, cashew pests, coconut pests, areca nut pests, pulse pests, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) Unit 5: Insects of medicinal importance: <ul style="list-style-type: none"> • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas Unit 6: Termites: <ul style="list-style-type: none"> • social organization, termitaria and termite control measures 	15
MODULE 3 Useful insects and pest management	Unit 7: Useful insects: <ul style="list-style-type: none"> • Honeybees (Apiculture); Mulberry silk worm (sericulture); lac insects (lac culture) Unit 8: Insect pest control methods: <ul style="list-style-type: none"> • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) Unit 9: Role of insects in ecosystem services	15

PRACTICAL COMPONENT OF BASIC AND APPLIED ENTOMOLOGY ZOO-VI.E-14 PRACTICAL (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	PRACTICAL	NO. OF PRACTICALS (12)
1.	Collection techniques of Insects – light traps, sweep net, Berlese funnel	02
2.	Identification and study of economically important insects.	02
3.	Field trips to ICAR Old Goa / Govt. of Goa agriculture department/ National Malaria Research Institute (NMRI).	02
4.	Study of insects of college campus dragon fly/ pests of different plants.	03
5.	Study of local insect pests of agriculture.	03

REFERENCE BOOKS:

- 1) Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.
- 2) Awasthi, V.B (2007): Introduction to general and applied entomology, 2nd edition. Scientific publishers India Jodhpur.
- 3) David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.
- 4) Reddy, D.S (2010) Applied entomology, 2nd edition New Vishal publications

REFERENCE BOOKS FOR PRACTICALS:

1. Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.
2. Varasi, M.S. (1992): Text book of entomology, Himalaya Publishing House, 1st edition.

ELECTIVE COURSE: LABORATORY TECHNIQUES IN PATHOLOGY	
COURSE CODE	ZOO-VI.E-15
MARKS	100 [75 -Theory; 25- Practical]
CREDITS	04 [03 -Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	This course is an introduction to the various techniques used in pathological diagnosis.
LEARNING OUTCOME	Upon successful completion of the course, students will be able to: <ul style="list-style-type: none"> ▪ Know the tests done for disease detection of various body fluids and tissues. ▪ Understand the clinical implication of the pathological tests.

ZOO-VI.E-15: LABORATORY TECHNIQUES IN PATHOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: BLOOD ANALYSIS	UNIT 1: Introduction to medical lab techniques and its importance UNIT 2: : Analyses of human Blood: <ul style="list-style-type: none">• Ways of obtaining blood samples, precautions and complications.• Methods of estimation and clinical significance of: hemoglobin, Packed Cell Volume (PCV), RBC count, WBC count, Complete Blood Count (CBC), platelets, Erythrocyte Sedimentary Rate (ESR), Differential Leucocyte Count (DLC).	15
MODULE 2: EVALUATION OF EXCRETORY MATERIAL AND GAMETES	UNIT 3:.Urine Analyses <ul style="list-style-type: none">• Physical characteristics, preservation of urine sample• Gross examination, chemical examination, abnormal constituents and its clinical implications.• Microscopy of urinary sediments UNIT 4: Stool Analyses <ul style="list-style-type: none">• Stool tests for protozoan parasites and helminth eggs.• Clinical significance. UNIT 5: Semen analyses: <ul style="list-style-type: none">• Constituents of semen• Gross and microscopic, cytochemical examination, clinical implications.	15
MODULE 3: LIVER FUNCTION CYTOLOGY IMAGING	UNIT 6: Clinical status of liver function - <ul style="list-style-type: none">• Function of liver.• Tests of excretion by liver, evaluation of synthesis in liver, evaluation of enzyme activity. UNIT 7: Clinical cytological studies <ul style="list-style-type: none">• Fine Needle Aspiration Cytology (FNAC), Ultrasound guided FNAC, aspiration of intra thoracic masses,<ul style="list-style-type: none">• Techniques of preparing cell smears, staining techniques UNIT 8: Medical imaging <ul style="list-style-type: none">• X-Ray, PET, CT Scan, MRI, DEXA Scan, Ultrasound, Doppler's Test (using photographs/reports etc).	15

PRACTICAL COMPONENT OF: LABORATORY TECHNIQUES IN PATHOLOGY ZOO-VI.E-15 - (30 HOURS – 02hrs/WEEK)		
SR. NO	PRACTICAL	NO. OF PRACTICALS
1.	Preparation of blood smears and staining techniques (Leishman's staining, Giemsa staining, Field's staining).	02
2.	Use of different types of anticoagulants, obtaining serum from blood, preparation of cell suspension (blood cells).	01
3.	RBC Count, WBC Count, Differential WBC Count	03
4.	Urine analysis – normal and abnormal constituents	02
5.	Blood sugar estimation using glucometer	01
6.	Estimation of hemoglobin (Sahli's method)	01
7.	Estimation of PCV	01
8.	Estimation of ESR (Wintrobe's / Westergreen method)	01

REFERENCE BOOKS:

1. Sood R (1999). Medical laboratory techniques, Jaypee publishers, New Delhi.
2. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
3. Godkar P.B. and Godkar D.P (2007). Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House.
4. Cheesbrough M (2002)., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
5. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd. New Delhi.

ELECTIVE COURSE: BIOENTREPRENEURSHIP

COURSE CODE	ZOO-VI.E- 16
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	<ul style="list-style-type: none">• To help students recognize the opportunities of enterprises in the field of life sciences• To encourage students to think independently and explore new vistas• To familiarise them with the basic skills required for a start-up
LEARNING OUTCOME	At the end of the course, <ul style="list-style-type: none">• Students will be exposed to various opportunities available in life science for start-ups.• They will be familiar with the methodologies and regulations required to start an enterprise.• It will also help the student to develop independent thinking skill required at the time of crucial decision making.

ZOO-VI.E- 16: BIOENTREPRENEURSHIP

UNIT	TOPICS	CONTACT HOURS
MODULE 1: Entrepreneurship Development	Unit 1: Introduction to entrepreneurship: <ul style="list-style-type: none">entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: <ul style="list-style-type: none">identifying business opportunities Unit 3: Raising funds: public and private	15
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	Unit 4: Business model canvas Unit 5: Guidelines and regulations: <ul style="list-style-type: none">Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6: Role of micro, medium and small scale industry sector Unit 7: Innovations in research: <ul style="list-style-type: none">writing project proposals to various funding bodies such as MHRD, UGC, DST, DBT, etc.	15
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 8: Intellectual Property Rights and trademark of biological resources Unit 9: quality, safety and procedural compliances <ul style="list-style-type: none">Bio safety and its implementationsQuality control in entrepreneurshipWHO Guidelines for setting up of a contract research organization.Starting a research laboratory in India – guidelines and permits required	15

PRACTICAL COMPONENT OF BIOENTREPRENEURSHIP ZOO-VI.E-16 (30 HOURS – 02hrs/WEEK)		
SR. NO.	PRACTICAL	NO. OF PRACTICAL
1.	Exercises on lateral thinking	01
2.	Testing entrepreneurial competencies	01
3.	Online search for patented technologies	01
4.	Identifying Business Opportunities	02
5.	Business Model Canvas	03
6.	Presentation of Business Model Canvas by students	01
7.	Interaction with successful entrepreneur	02
8.	Interaction with Banker/ Angel Investor	01

REFERENCES:

1. Garg, M.C. (2015) Entrepreneurial development. Guset User.
2. Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4th edition. www.evelexa.com

Additional reading:

1. Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .
2. Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.

WEBLIOGRAPHY:

1. <http://www.creativeboom.com/resources/10-free-brain-teasing-puzzle-resources-for-team-building-games-and-getting-your-creative-juices-flowing/>
2. <https://www.scribd.com/document/60183753/39034324-Test-for-Personal-Entrepreneurial-Competencies>
3. http://www.wipo.int/edocs/pubdocs/en/patents/434/wipo_pub_1434_02.pdf
4. <https://ipindiaonline.gov.in/patentsearch/Granted%20Search%20Engine%20Help%20file.pdf>
5. <https://canvanizer.com/new/business-model-canvas>