Bachelor of Science (Honours) Zoology under CBCS

PATNA UNIVERSITY, PATNA

Programme Code:

Programme Outcomes

At the completion of the programme, students will attain the ability to:

PO1. Disciplinary knowledge: Acquire comprehensive knowledge of major concepts, theoretical principles and experimental findings in zoology, and some of the applied areas of study such as wildlife conservation and management; environmental science; various techniques, instruments, used for analysis of animals' forms and functions.

PO2. **Effective communication and Critical thinking**: Convey the intricate zoological information effectively and efficiently, analyze and solve the problems related to animal sciences without relying on assumptions and guesses.

PO3. **Research & Leadership quality**: Recognize and mobilize relevant resources essential for a research project, and manage the project in a responsible way by following ethical scientific conduct and bio-safety protocols.

PO4. Digitally literate and Ethical awareness: Use computers for computation and data analysis with appropriate software for biostatistics, and employ search tools to locate and retrieve relevant information, recognize and avoid unethical behaviour such as fabrication, or misrepresentation of data or commit plagiarism.

PO5. **Environment and Sustainability**: Understand the environmental and sustainability issues, acquire self-paced and self-directed learning aimed at personal and social development.

Programme Specific Outcomes

At the completion of the programme, students will attain the ability to:

PSO1. Identify, classify and differentiate diverse chordates and non-chordates based on their morphological, anatomical and systemic organization.

PSO2. Describe economic, ecological and medical significance of various animals in human life. This will create a curiosity and awareness among them to explore the animal diversity and take up wild life photography or wild life exploration as a career option. The knowledge about identifying and classifying animals will provide students professional advantages in teaching, research and taxonomist jobs in various government organizations; including Zoological Survey of India and National Parks/Sanctuaries.

PSO3. Acquire practical skills in cell & molecular biology, biochemistry, genetics, enzymology These methodologies will provide an extra edge to our students, who wish to ndertake higher studies.

PSO4. Understand comparative anatomy and developmental biology of various biological systems; and learning about the organisation, functions, strength and weaknesses of various systems will let student critically analyse the way evolution has shaped these traits in human body.

PSO5. Skill enhancement course like medical diagnostics will provide them opportunity to work in diagnostic or research laboratory.

PSO6. Students undertaking wild life management courses would gain expertise in identifying key factors of wild life management and be aware about different techniques of estimating, remote sensing and Global positioning of wild life. This course will motivate students to pursue career in the field of wildlife conservation and management.

Course Structure

Semester –I

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Diversity and evolution of Non-Chordates I:Protista to Pseudomonas (Th)	CC-1 (Th)	4-1-0	4	100
2	Diversity and evolution of Non-Chordates I:Protista to Pseudomonas (P)	CC-1 (P)	0-0-6	2	100
3	Principles of Ecology (Th)	CC-2 (Th)	4-1-0	4	100
4	Principles of Ecology (P)	CC-2 (P)	0-0-6	2	100
5	English Communication/MIL	AECC- 1	2-1-0	2	100
6	Generic Elective- 1 (Th)	GE- 1 (Th)	4-1-0	4	100
7	Generic Elective- 1 (P)	GE- 1 (P)	0-0-6	2	100
				Total credit- 20	

Semester –II

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Diversity and evolution of Non-Chordates II:Coelomates (Th)	CC-3 (Th)	4-1-0	4	100
2	Diversity and evolution of Non-Chordates II:Coelomates (P)	CC-3 (P)	0-0-6	2	100
3	Diversity and Distribution of Chordates (Th)	CC-4 (Th)	4-1-0	4	100
4	Diversity and Distribution of Chordates (P)	CC-4 (P)	0-0-6	2	100
5	Environmental Science	AECC- 2	2-1-0	2	100
6	Generic Elective- 2 (Th)	GE- 2 (Th)	4-1-0	4	100
7	Generic Elective- 2 (P)	GE- 2 (P)	0-0-6	2	100
Total credit - 20					

Semester – III

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Comparative Anatomy of Vertebrates (Th)	CC-5 (Th)	4-1-0	4	100
2	Comparative Anatomy of Vertebrates (P)	CC-5 (P)	0-0-4	2	100
3	Physiology: Life sustaining System (Th)	CC-6 (Th)	4-1-0	4	100
4	Physiology: Life sustaining System (P)	CC-6 (P)	0-0-4	2	100
5	Physiology: Controlling and Coordination (Th)	CC-7 (Th)	4-1-0	4	100
6	Physiology: Controlling and Coordination (P)	CC-7 (P)	0-0-4	2	100
7	Skill Enhancement Course- 1	SEC- 1	2-1-0	2	100
8	Generic Elective- 3 (Th)	GE- 3 (Th)	4-1-0	4	100
9	Generic Elective- 3 (P)	GE- 3 (P)	0-0-4	2	100
Total credit - 26					

Semester – IV

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Biochemistry (Th)	CC-8 (Th)	4-1-0	4	100
2	Biochemistry (P)	CC-8 (P)	0-0-4	2	100
3	Cell Biology (Th)	CC-9 (Th)	4-1-0	4	100
4	Cell Biology (P)	CC-9 (P)	0-0-4	2	100
5	Genetics (Th)	CC-10 (Th)	4-1-0	4	100
6	Genetics (P)	CC-10 (P)	0-0-4	2	100
7	Skill Enhancement Course- 2	SEC- 2	2-1-0	2	100
8	Generic Elective- 4 (Th)	GE- 4 (Th)	4-1-0	4	100
9	Generic Elective- 4 (P)	GE- 4 (P)	0-0-4	2	100
Total credit - 26					

Semester – V

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Molecular Biology (Th)	CC-11 (Th)	4-1-0	4	100
2	Molecular Biology (P)	CC-11 (P)	0-0-4	2	100
3	Immunology (Th)	CC-12 (Th)	4-1-0	4	100
4	Immunology (P)	CC-12 (P)	0-0-4	2	100
5	Discipline Specific Elective- 1 (Th)	DSE- 1 (Th)	4-1-0	4	100
6	Discipline Specific Elective- 1 (P)	DSE- 1 (P)	0-0-4	2	100
7	Discipline Specific Elective- 2 (Th)	DSE- 2 (Th)	4-1-0	4	100
8	Discipline Specific Elective- 2 (P)	DSE- 2 (P)	0-0-4	2	100
Total credit - 24					

Semester – VI

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Development Biology (Th)	CC-13 (Th)	4-1-0	4	100
2	Development Biology (P)	CC-13 (P)	0-0-4	2	100
3	Evolution Biology (Th)	CC-14 (Th)	4-1-0	4	100
4	Evolution Biology (P)	CC-14 (P)	0-0-4	2	100
5	Discipline Specific Elective- 3 (Th)	DSE- 3 (Th)	4-1-0	4	100
6	Discipline Specific Elective- 3 (P)	DSE- 3 (P)	0-0-4	2	100
7	Discipline Specific Elective- 4 (Project/Dissertation)	DSE- 4	0-0-6	6	100
Total credit - 24					

Total Credits – 140

***L/T/P: number of classes per week**

DSE/GE may either carry 6 credit, i.e., ***Theory (4 credit) + Practical (2 credit) format***

Or

Consolidated (6 credit) for Theory only

Discipline Specific Elective Course (DSE):

Course name	L-T-P
1. Animal Behaviour and Chronobiology 2. Biology of Insect 3. Biostatistics 4. Fish Biology 5. Wildlife Conservation and Management	

Generic Elective (GE):

For Zoology Students		For Other Students	
Course name	L-T-P	Course name	L-T-P
		1. Animal Diversity 2. Environment and Public Health 3. Food, Nutrition and Health 4. Insect Vectors and Diseases	

Skill Enhancement courses (SEC):

1. Medical Diagnostics
2. Research Methodology

SEMESTER – I

CC1 : Diversity and Evolution of Non-chordates upto Pseudocoelmates

Course Outcomes

After the completion of the course, the students will be able :

CO1- To learn & interpret the importance of taxonomy and classify Protista, Parazoa, Metazoa, Porifera, Cnidaria, Platyhelminthes and Nemathelminthes.

CO2- To understand and explain the economic importance and describe the life cycle and pathogenecity of *P. vivax*, *E. histolytica*, *Schistosoma haematobium*, *Taenia solium*, *Ascaris lumbricoides* and *Wuchereria bancrofti;*

CO3- To appreciate the diversity and complexities exhibited by non-chordates and familiarize with the morphology, anatomy and functioning of different groups of non-chordates.

CO4- To Critically analyze the organization, complexity and adaptations in parasitic Nemathelminthes and Platyhelminthes; affinities and Evolutionary significance of Ctenophora and to enhance collaborative learning through practical sessions, assignments and projects.

CC1 : Diversity and Evolution of Non-chordates upto Pseudocoelmates (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Protista, Parazoa and Metazoa** 1.1 General characteristics and classification up to orders. 1.2 Life cycle and pathogenicity of *P. vivax* and *E. histolytica, L. donovani*. 1.3 Locomotion and reproduction in Protista. 1.4 Evolution of symmetry and segmentation of metazoan	18
2	**Porifera, Cnidaria and Ctenophora** 2.1 General characteristics and classification up to orders. 2.2 Canal system in sponges. Metagenesis in Obelia; Polymorphism in Cnidaria; Corals and coral reefs. 2.3 Evolutionary significance of Ctenophora	16
3	**Platyhelminthes** 3.1 General characteristics and classification up to orders 3.2 Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium.*	10

4	**Nemathelminthes** 4.1 General characteristics and classification up to orders 4.2 Life cycle, pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*. 4.3 Parasitic adaptations in Helminthes	16
	TOTAL	60

Reading List :

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Verma P S, Jordan E L. (2009). Invertebrate Zoology. S. Chand publishers
5. Brusca R C (2016). Invertebrates. Published by Sinauer Associates, an imprint of Oxford University Press.

CC1 : Diversity and Evolution of Non-chordates upto Pseudocoelmates (Practical) (2 credit)	
Practical 1. Prepare permanent/temporary slide of the given specimen (any one). Euglena, amoeba, Paramaceium-binary fission and conjugation, obelia colony 2. Identify and comment upon the etiology of given specimen (any one). *Fasciola hepatica, Taenia solium, Plasmodium vivax* and *Ascaris lumbericoids* 3. Identify and comment upon given spots. Slides: T.S. and L.S. body wall of Sycon, Medusa (WM), Spicules of Sponges, Gemmules of Sponges, Obelia (WM), Balantidium (WM) Museum Specimen: Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora 4. Examination of pond water for the presence of Protista 5. Practical notebook/ Chart/ Model 6. Viva-voce	30
TOTAL	30

CC2 : Ecology

Course Outcomes

After the completion of the course, the student will be able:

CO1-To understand and relate the key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors.

CO2- To understand and explain the population attributes; population growth models and population interactions and to understand and describe the community characteristics and ecological succession

CO3- To understand and describe the different ecosystems, food chains, energy flow & efficiency; biogeochemical cycles.

CO4- To learn and relate the application of the basic principles of ecology in wildlife conservation and management.

CC2 : Ecology (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction to Ecology** 1.1 Relevance of studying ecology, Autecology and synecology, 1.2 levels of organization 1.3 Laws of limiting factors, temperature, soil and light as physical factors.	12
2	**Population** 2.1 Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio 2.2 Population growth- Exponential and logistic growth, equation and patterns, r and K strategies, 2.3 Population regulation - density-dependent and independent factors; Population interactions, Gause's Principle	16
3	**Community** 3.1 Community characteristics: Dominance, diversity, species richness, abundance, stratification Ecotone and edge effect 3.2 Ecosystem development (succession) with example	12
4	**Ecosystem & Biodiversity Conservation** 4.1 Types of ecosystems with Pond as an example, Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains, Food web 4.2 Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies. Nutrient and biogeochemical cycle with one example of Nitrogen cycle 4.3 Types of biodiversity and its significance, loss of biodiversity, Conservation strategies, Application of ecology in wild life conservation	20
	TOTAL	60

Reading List :

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres

CC2 : Ecology (Practical) (Practical: 2 credits)	
Practical 1. Physiochemical analysis of water sample: pH, Temperature and Dissolved Oxygen. 2. Study of life tables and plotting of survivorship curves of different types from the hypothetical data provided. 3. Identify and comment upon given spots. Zooplanktons-2, Zoomacrobenthos-2, Nekton-4 4. Determination of population density in a natural/ hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community. 5. Practical notebook/ Chart/ Model 6. Viva-voce	30

TOTAL	30

Semester II

CC3 : Diversity and Evolution of Non-chordates: Coelomates

Course Outcomes

After the completion of the course, the student will be able:

CO1- To classify and compare phylum Annelida, Arthropoda, Mollusca and Echinodermata.

CO2 To understand and describe Excretion in Annelida; Vision and Respiration in Arthropoda; Metamorphosis in Insects; Social life in bees and termites.

CO3- To understand and describe Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves.

CO4- To understand and describe the Water-vascular system in Asteroidea; Larval forms in Echinodermata.

CC3 : Diversity and Evolution of Non-chordates: Coelomates (Theory: 4credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Phylum Annelida** 1.1 General characteristics and classification up to classes 1.2 Evolution of Coelom and Metamerism 1.3 Excretion in Annelida	15
2	**Phylum Arthropoda and Onychophora** 2.1 General characteristics and evolutionary significance of Onychophora 2.2 Vision and Respiration in Arthropoda 2.3 Metamorphosis in Insects 2.4 Social organisation in honey bees	15
3	**Phylum Mollusca** 3.1 General characteristics and classification up to classes 3.2 Respiration in Mollusca 3.3 Torsion and detorsion in Gastropoda 3.4 Pearl formation in bivalves 3.5 Evolutionary significance of trochophore larva	15
4	**Phylum Echinodermata** .1 General characteristics and classification up to classes 4.2 Water-vascular system in Asteroidea 4.3 Larval forms in Echinodermata 4.4 Affinities with Chordates	15
	TOTAL	60

Reading List :

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
2. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *TheInvertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Verma P S, Jordan E L. (2009). Invertebrate Zoology. S. Chand publishers
5. Brusca R C (2016). Invertebrates. Published by Sinauer Associates, an imprint of Oxford University Press.

6. Ganguli et al (2018). Biology of Animals. NCBA Publications.

CC3 : Diversity and Evolution of Non-chordates: Coelomates (Practical) (Practical: 2 credits)	
Practical : 1. Prepare permanent/temporary slide of the given specimen (any one). Daphnia, Cyclops, Mysis. 2. Identify and comment upon the social behaviour/ etiology of given specimen (any one). Honey Bees, and Ants 3. Identify and comment upon given spots. Slides: T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm, T.S through crop of leech. Whole mount of Echinoderm and Crustacean larvae Museum Specimen: *Chitton, Pila, Unio, Mytilus, Loligo, Sepia, Octopus* and *Nautilus, Pentaceros/Asterias, Ophiura, Echinocardium, Cucumaria and Antedon* 4. Examination of pond water for the presence of Crustacean larvae 5. Practical notebook/ Chart/ Model 6. Viva-voce	30
TOTAL	30

CC4 : Diversity and Evolution of Chordates

Course Outcomes

After the completion of the course, the student will be able:

CO1- To understand the General Characteristics and Classification of Hemichordata, Urochordata and Cephalochordata, the Larval forms of Protochordata and Retrogressive Metamorphosis in Urochordata.

CO2- To acquire knowledge about the General Characters and Classification of Agnatha, Pisces and Amphibia.

CO3- To understand the General Characteristics and Classification of Reptilia, Aves and Mammals, Biting Mechanism in Snakes, Flight Adaptations in Birds and Migration in Birds.

CO4- To know about the Zoogeographical Realms and Characteristic Fauna.

CC4 : Diversity and Evolution of Chordates (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Origin and outline classification of Chordates** 1.1 General characteristics and classification of Protochordata 1.2 General characteristics of Hemichordata, Urochordata and Cephalochordata 1.3 Retrogressive metamorphosis in Urochordata 1.4 Theories concerned with origin of Chordates 1.5 Advanced features of vertebrates over Protochordata	15
2	**Agnatha and Pisces** 2.1 General characters and classification of cyclostomes up to class 2.2 General characters of Chondrichthyes and Osteichthyes and outline its classification 2.3 Migration in fishes, Osmoregulation and accessory respiratory organs in fishes	13
3	**Amphibia and Reptilia** 3.1 Origin and evolution of Amphibia 3.2 General characters and classification up to order 3.3 Parental care in Amphibia 3.4 Neoteny	17

	3.5 Affinities of *Sphenodon* 3.6 Poison apparatus and Biting mechanism in snakes	
4	**Aves and Mammals** 4.1 General characters and classification up to order 4.2 Flight adaptations 4.3 Migration in birds 4.4 Affinities of Prototheria and Metatheria 4.5 Adaptive radiation in mammals	15
	TOTAL	40

Reading List :

1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life,* VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. Classification from Young, J. Z. (2004) to be followed .

CC4 : Diversity and Evolution of Chordates (Practical) **(Practical: 2 credits)**	
Practical : 1. Prepare permanent/temporary slides of the given specimen(any one): Mounting of cycloid, ctenoid/placoid scales, Webarian ossicles of bony fish 2. Identify and comment upon given spots: Museum specimen (four in number): Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Hippocampus, Anabas, Ichthyophis, Bufo, Hyla, Alytes, Chelone, Hemidactylus, Varanus, Chamaeleon, Draco, Bungarus, Vipera, Hydrophis, Bat Slides (four in number): Section of Balanoglossus through Proboscis and branchiogenital region, Section of Amphioxus through pharyngeal, intestinal and caudal region; Histological slides of fishes, amphibia, reptiles, birds and mammals 3. Identify and comment upon the given specimen of snake (poisonous/non-poisonous) based on key 4. Comment upon the given beaks/ claws/ locally available birds 5. Practical records/charts/models 6. Viva voce	30
TOTAL	30

SEMESTER – III

CC5 : Comparative anatomy of vertebrates

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To describe the function and derivative of integument

CO 2- To explain the Evolution of heart and aortic arches

CO 3- To compare structure and function of the Alimentary canal and associated glands

CO 4- To evaluate the techniques relating to the nervous system and how they within the body respond to challenges.

CC5 : Comparative anatomy of vertebrates (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Integumentary and skeleton System** 1.1 Structure, functions and derivatives of integument 1.2 Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	15
2	**Digestive & Respiratory System** 2.1 Alimentary canal and associated glands 2.2 Skin, gills, lungs and air sacs; Accessory respiratory organs	15
3	**Circulatory and urinogenital system** 3.1 General plan of circulation, evolution of heart and aortic arches 3.2 Succession of kidney, Evolution of urinogenital ducts.	15
4	**Nervous System including sense organ** 4.1 Comparative account of brain, Autonomic nervous system, Spinal cord, Cranial nerves in mammals 4.2 Classification of receptors, Brief account of visual receptors, chemo-receptors and mechanoreceptors	15
	TOTAL	60

Reading List :

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution.* IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of Vertebrates*. IX Edition. The McGraw-Hill Companies
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House
5. Saxena R K (2008). *Comparative Anatomy of Vertebrates.* Viva Books Private Limited

CC5 : Comparative anatomy of vertebrates (Practical) (Practical: 2 credits)	
Practical 1. Study of permanent slides of placoid, cycloid and ctenoid scales of fishes 2. Study of bones of Frog, Varanus, Fowl and Rabbit: Disarticulated skull, vertebrae, pectoral girdle, pelvic girdle and limb bones. 3. Study of histological features of any two organs based on models of mammals: Heart/ lung/ kidney/ eye/ ear 4. Study of features of mammalian skull (Herbivore & Carnivore) 5. Practical Records/ Charts/ model 6. Viva voce	30
TOTAL	30

CC6 : Animal Physiology : Life sustaining systems

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To compare the mechanical and chemical digestion of food

CO 2- To remember and understand hormonal control of secretion of enzymes in gastrointestinal tract

CO 3- To acquire knowledge of mechanism of breathing, Pulmonary ventilation and its control and to understand the concept of haemostasis and blood clotting system.

CO 4- To explain origin and conduction of cardiac impulses and cardiac cycles.

CC6 : Animal Physiology: Life sustaining systems (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Digestive System** 1.1 Structural organization and functions of gastrointestinal tract and its associated glands 1.2 Mechanical and chemical digestion of food 1.3 Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins 1.4 Role of gastrointestinal hormones on the secretion and control of enzymes of Gastrointestinal tract.	15
2	**Respiratory System** 2.1 Mechanism of respiration, Pulmonary ventilation, Respiratory volumes and capacities 2.2 Transport of oxygen and carbon dioxide in the blood, Respiratory pigments 2.3 Dissociation curve and influencing factors 2.4 Carbon monoxide poisoning	15
3	**Excretory System** 3.1 Structure of kidney and its histological details 3.2 Renal blood supply 3.3 Mechanism of urine formation and its regulation 3.4 Regulation of acid-base balance	13
4	**Cardiovascular system** 4.1 Components of blood and their functions 4.2 Haemopoiesis, Haemostasis and Coagulation of blood 4.3 An outline structure of heart; Coronary circulation; structure of conducting and working myocardial fibers. 4.4 Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart 4.5 Nervous and chemical regulation of heart rate 4.6 Blood pressure and its regulation, Electrocardiogram	17
	TOTAL	60

Reading List :

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
5. Geetha N. (2014). Textbook of Medical Physiology. Paras Medical Publisher.

CC6 : Animal Physiology: Life sustaining systems (Practical) (Practical: 2 credits)	
Practical : 1. Enumeration of red blood cells using haemocytometer or Study of activity of salivary amylase under optimum condition. 2. Estimation of haemoglobin using Sahli's haemoglobinometer. 3. Preparation of haemin and haemochromogen crystals. 4. Identify and comment upon given spots / sections:Mammalian oesophagus, stomach, pancreas, duodenum, ileum, rectum, liver, trachea, lung, kidney 5. Practical records/ charts/ model 6. Viva – voce	30
TOTAL	30

CC7 : Animal Physiology- Controlling and coordinating System

Course Outcomes

After the completion of the course, the student will be able:

CO1- To know about different types of Tissues, Bone and Cartilage

CO2- To acquire knowledge of structure and function of muscular tissue.

CO3- To acquire knowledge about the structure and function of Nervous System.

CO4- To understand the structure and function of Male and Female Reproductive System.

CC7 : Animal Physiology- Controlling and coordinating System (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Muscles, Bones and Cartilage** 1.1 Tissue structure, location, function and classification of epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue and glands 1.2 Histology and types of bones and cartilages, Ossification, bone growth, resorption 1.3 Types and functional diversity of muscle, ultrastructure of skeletal muscle, muscle proteins, muscle contraction, elementary knowledge of muscle twitch, tetanus and fatigue	13
2	**Nervous System** 2.1 Structure and types of neurons 2.2 Resting membrane potential and action potential, Generation and propagation of action potential across the nerve fibers (myelinated and unmyelinated) 2.3 Types of synapse and Synaptic transmission 2.4 Reflex action and its types 2.5 Physiology of hearing and vision	17
3	**Reproductive System** 3.1 Histology of testis and ovary 3.2 Physiology of male and female reproduction 3.3 Puberty and methods of contraception in male and female	13
4	**Endocrine System** 4.1 Definition and classification of hormones; Endocrine, Paracrine and autocrine mode of hormones delivery 4.2 General mechanism and feedback mechanism of hormone action 4.3 Hypothalamo-hypophysical systems; Histology of endocrine glands (Pineal, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Gonads)	17

	4.4 Biosynthesis, biological actions, mechanism of action and regulation of secretion of hormones 4.5 Hormonal dysfunction and diseases (Dwarfism, Acromegaly, Goiter, Addison's disease, Diabetes mellitus)	
	TOTAL	60

Reading List:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
5. Geetha N. (2014). Textbook of Medical Physiology. Paras Medical Publisher.

CC7 : Animal Physiology- Controlling and coordinating System (Practical) (Practical: 2 credits)	
Practical 1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) 2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells 3. Identify and comment upon the spot: Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis, Ovary) 4. Preparation of permanent slide of Paraffin spread section of any mammalian tissue Or submission of project report on methods of contraception in male and female. 5. Practical Records/Charts/Models 6. Viva voce	30
TOTAL	30

SEMESTER – IV
CC8 : Biochemistry

Course Outcomes

After the completion of the course, the student will be able :

CO1- To understand the Structure, Classification and Importance of Carbohydrates and Proteins.

CO2- To understand the Structure and Significance of physiologically important Lipids.

CO3- To understand the Basic Structure and Types of DNA and RNA, Base pairing, Denaturation and Renaturation of DNA.

CO4- To understand the Types of Enzymes, Mechanism of Enzyme Action and Enzyme Kinetics.

CC8 : Biochemistry (Theory: credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Elementary idea of biomolecule** 1.1 Carbohydrate structure and biological importance: Monosaccharides, Disaccharides, polysaccharides and glycoconjugates. 1.2 Lipids-Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Try-acylglycerols, Phospholipids, Glycolipids, Steroids. 1.3 Amino acids and Proteins Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids. Proteins: Bond stabilising protein structure; Levels of organisation in proteins; Denaturation; Introduction to simple and conjugate proteins.	17
2	**Enzymes** 2.1 Nomenclature and classification 2.2 Co-factors specificity of enzyme action, Isozymes 2.3 Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalysed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax Lineweaver-Burk plot; Multi-substrate reactions	13
3	**Carbohydrate Metabolism and Oxidative phosphorylation** 3.1 Sequence of reactions and regulation of glycolysis, Citric acid cycle 3.2 Pentose Phosphate Pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.	15
4	**Lipid and Protein Metabolism** 4.1 Lipid Metabolism: Beta oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis 4.2 Protein Metabolism: Catabolism of amino acids, Transamination, Deamination, Urea cycle; 4.3 Fate of C-skeleton of Glucogenic and Ketogenic amino acids.	15
	TOTAL	60

Reading List :

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

CC8 : Biochemistry(Practical) (Practical: 2 credits)	
Practical 1. Qualitative tests of carbohydrates, proteins and lipids. 2. Paper chromatography of amino acids. 3. Demonstration of impact of pH, temperature and inhibitors on the action of salivary amylase. 4. Estimation of total protein/SGPT/ALP/ ACP in serum. 5. Practical Records/Charts/Models 6. Viva voce	30
TOTAL	30

CC9 : Cell Biology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To understand the structures and purposes of basic components of Prokaryotic and Eukaryotic cells.

CO 2- To understand the structures and functions of Plasma Membrane, Endomembrane System and Cytoskeleton.

CO 3- To understand the detailed structure of Mitochondria and how energy is produced by it through the Respiratory chain.

CO 4- To understand the detailed structure of Nucleus and its associated structures, Cell Division, Cell Cycle and Cell Signaling

CC9 : Cell Biology (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Elementary Idea on different life forms** 1.1 Prokaryotic and Eukaryotic cells 1.2 Virus, Viroids, Mycoplasma, Prions	13
2	**Plasma Membrane** 2.1 Various models of plasma membrane structure. 2.2 Transport across membranes 2.3 Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata	15
3	**Endomembrane System, Mitochondria & Cytoskeleton** 3.1 The Endoplasmic Reticulum, Golgi Apparatus, Mechanism of vesicular transport, Lysosomes, Polymorphism of Lysosomes, Peroxisomes 3.2 Mitochondria - Structure, Semiautonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis. 3.3 Cytoskeleton - Elementary idea, Microtubules and Microfilaments.	17
4	**Nucleus** 4.1 Ultra structure of nucleus 4.2 Nuclear Envelope - Structure of nuclear pore complex, Transport of molecules across nuclear membrane, Structure and function of Nucleolus. 4.3 Chromatin - Chromosomal DNA and its packaging (Nucleosome), Euchromatin & Heterochromatin. 4.4 Cell cycle and its regulation	15
	TOTAL	60

Reading List :

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

CC9 : Cell Biology (Practical) **(Practical: 2 credits)**	
Practical : 1. Preparation of acetocarmine squash onion root tip cell for mitosis. Or grasshopper testis for meiosis 2. Histochemical demonstration of any one – I. Lipid by sudan black method II. Mucopolysaccharides by PAS (Periodic Acid-Schiff) Reaction. III. Proteins by Mercurobromophenol blue/ Fast Green 3. Identify and comment upon spots: stages of mitosis and meiosis, Barr bodies. 4. Submission of Permanent slides. 5. Practical records/Charts/Models. 6. Viva-voce	30
TOTAL	30

CC10 : Principles of Genetics

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To explain and discuss the genetic variation through linkage and crossing over.

CO 2- To describe sex-linked, sex limited and sex influenced inheritance.

CO 3- To understand the Concept behind genetic disorder, gene mutations and molecular basis of mutations and to explain the criteria for extra-chromosomal inheritance.

CO 4- To describe the molecular mechanisms of recombination in bacteria and to explain and distinguish the concept of transposable genetic elements in prokaryotes and eukaryotes. Solve genetic based problems.

CC10 : Principles of Genetics **(Theory: credits)**		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Mendelian Genetics and Linkage** 1.1 Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis and Pleiotropy 1.2 Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence.	17

2	**Mutations** 2.1 Gene mutation and its types, Chromosomal mutations: Deletion, duplication, inversion, translocation, aneuploidy and polyploidy 2.2 Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations in Drosophila: CLB method and attached *X* method	15
3	**Sex Determination** 3.1 Chromosomal mechanisms of sex determination; Sex-linked inheritance, sex-influenced and sex-limited characters.	13
4	**Extra-chromosomal Inheritance and Quantitative Genetics** 4.1 Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations, Kappa particles in *Paramoecium* and Maternal effects (Shell spiralling in *snail*). 4.2 Polygenic inheritance and Transgressive variation	15
	TOTAL	60

Reading List :

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach*.III Edition. Benjamin Cummings
5. Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.

CC10 : Principles of Genetics (Practical) **(Practical: 2 credits)**	
Practical : 1. Preparation of polytene chromosomes from *Chironomous*/*Drosophila* larva. 2. Identification of various mutants of *Drosophila* in the given photograph/ specimen. 3. Calculate allelic/ genotypic frequencies using Hardy-Weinberg's Principle. 4. Solving genetical problem based on Mendelian laws and Linkage map from *Drosophila* crosses. 5. Pedigree Analysis of human inherited traits. 6. Practical Records / charts / models. 7. Viva-voce	30
TOTAL	30

Semester V

CC11 : Molecular Biology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To understand Central dogma of molecular biology. Explain and distinguish mechanism of replication, transcription and translation in prokaryotes and eukaryotes.

CO 2- To understand and explain the post transcriptional modifications in eukaryotes.

CO 3- To explain and differentiate the mechanism of gene expression and regulation in prokaryotes and eukaryotes

CO 4- To describe the concept of regulatory RNAs, Ribo-switches and RNA interference and to enhance skill in molecular biology through relevant experiments.

CC11 : Molecular Biology (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Basics of Nucleic Acid** 1.1 Central Dogma of Molecular Biology 1.2 Structure and topology of DNA, DNA forms: Plasmid DNA, Genomic DNA and Repetitive DNA. Conformation 1.3 Structure and Function of RNA, Ribosomal RNA (tRNa), Messenger RNA (mRNA).	15
2	**DNA replication and repair** 2.1 DNA Replication in prokaryotes (mode, mechanism and machinery) 2.2 DNA repair, mismatch repair, Base excision repair (BER), Nucleotide excision repair (NER), single strand-and double strand DNA repair. 2.3 Difference between prokaryotic and eukaryotic replication.	15
3	**Transcription** 3.1 RNA polymerase and transcription unit 3.2 Mechanism of transcription in prokaryotes (initiation , elongation and termination) 3.3 Difference between prokaryotic and eukaryotic transcription	15
4	**Translation** 4.1 Genetic code, degeneracy of genetic code and Wobble hypothesis 4.2 Ribosome – structure and Biogenesis 4.3 Translation in prokaryotes: Initiation, Elongation & Termination of polypeptide chain. 4.4 Difference between prokaryotes and eukaryotes translation.	15
	TOTAL	60

Reading List :

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter:*Molecular Biology of the Cell*, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.

CC11 : Molecular Biology (Practical) (Practical: 2 credits)	
Practical : 1. Perform any one of the given experiment: a) Demonstration of the presence of DNA by Feulgen reaction/ RNA by Methy green pyronin (MGP) b) Isolation of genomic DNA by ethanol precipitation method 2. Perform the agarose DNA gel electrophoresis of plasmid DNA/genomic DNA Or demonstration of antibiotic sensitivity/resistance of E. coli to antibiotics and interpretation of results 3. Estimate the growth kinetics of E. coli by turbidity method Or preparation of liquid and solid culture medium for E. coli 4. Practical records/ models/ charts 5. Viva-voce	30
TOTAL	30

CC12 : Immunology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To explain cells and organs of the immune system, innate and adaptive immunity.

CO 2- To describe autoimmunity with reference to rheumatoid arthritis and tolerance and AIDS.

CO 3- To understand antigens and its type, structure and functions of immunoglobulins, antigen-antibody interactions and immunoassays (such as ELISA and RIA).

CO 4- To explain structure and functions major histocompatibility complex, know the concept of hypersensitivity and vaccines.

CC12 : Immunology (Th) (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Basic Concept of immunity** 1.1 Overview of Immune System: Historical perspective of Immunology, Cells and organs of the Immune system 1.2 Innate and Adaptive Immunity: Anatomical barriers, inflammation, Cells and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral). 1.3 Passive and Active: Artificial and natural Immunity, Immunological Tolerance	15
2	**Antigen & Immunoglobulin** 2.1 Antigens: Antigenicity and immunogenicity, Adjuvants and haptens, Factors influencing immunogenicity 2.2 Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions	15
3	**MHC and Cytokines** 3.1 Major Histocompatibility Complex: Structure and functions of MHC molecules (MHC I and MHC II), Endogenous and exogenous pathways of antigen processing and presentation. 3.2 Cytokines: Properties and function of cytokines	15
4	**Complement system & Vaccines** 4.1 Complement System: Components and pathways of complement activation. 4. 2 Vaccines: Various types of vaccines.	15

	TOTAL	60

Reading List :

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Publication.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Edition. Saunders Publication.
3. Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V
4. Owen J A, Punt J, Stanford S A (2013). *Kuby Immunology* W H Freeman & Co;
5. Wood P. (2007). Basic Immunology. Pearson publication

CC12 : Immunology (Practical) (Practical: 2 credits)	
Practical : 1.Determination of ABO blood group using ABD antisera method. 2.Study of lymphoid organs (i) Kidney (ii) Spleen (iii) Bone marrow (iv) Lymph node 3.Comment upon working principle of RIA, Flow Cytometry, ELISA/dot ELISA 4. Demonstration of Immunoprecipitation and Immunoelectrophoresis 5. Practical Records/ Chart/ Model 6. Viva-voce	30
TOTAL	30

SEMESTER – VI

CC13 : Developmental Biology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To describe the mechanism of gametogenesis, fertilization and blocks to polyspermy.

CO 2- To explain early embryonic development in frog and chick.

CO 3- To understand the concepts of late embryonic development in model organisms.

CO4 - To describe post embryonic development such as metamorphosis and regeneration with suitable examples and apply important experiments and project work.

CC13 : Developmental Biology (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction** 1.1 Principles and Basic concepts of development biology: Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression. 1.2 Potency, commitment, specification (autonomous, regulative and syncytial), induction, competence, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, genomic equivalence and the cytoplasmic determinants.	15
2	**Early and Late Embryonic Development**	17

	2.1 Early Embryonic Development: Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, monospermy & polyspermy 2.2 Planes and patterns of cleavage, Types of Blastula, Fate maps (including Techniques). 2.3 Early development of frog and chick up to gastrulation, embryonic induction and organizers. 2.4 Late Embryonic Development: Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).	
3	**Post Embryonic Development** 3.1 Metamorphosis: Changes, hormonal regulations in amphibians; 3.2 Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each) 3.3 Ageing: Concepts and Theories	15
4	**Implications of Developmental Biology** 4.1 Teratogenesis: Teratogenic agents and their effects on embryonic development; 4.2 In vitro fertilization, Stem cell & (ESC), Amniocentesis	13
	TOTAL	60

Reading List:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

CC13 : Developmental Biology (Practical) (Practical: 2 credits)	
Practical 1.Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages) 2.Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 24, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages) 3.Study of the developmental stages and life cycle of Drosophila from stock culture 4.Study of different sections of placenta (photomicropgraph/ slides) 5.Practical/Project rep on Drosophila culture/chick embryo development. 6.Viva-voce	30
TOTAL	30

CC14 : Evolutionary Biology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To understand the basis of origin of life such as: chemogeny, RNA world, biogeny and evolution of eukaryotes.

CO 2- To obtain the various evolutionary concepts and heritable variation and to understand concept of species, isolating mechanisms, modes of speciation and adaptive radiation.
CO 3- To explain and different types of fossils, geological time scale, climatic conditions, hominid characteristics, primate phylogeny and evolution of horse and man.

CO 4- To understand Hardy-Weinberg principle of genetic equilibrium and its destabilizing forces such as Natural selection, Mutation, Migration and genetic drift.

CC14 : Evolutionary Biology (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Origin of Life** 1.1 Chemogeny, RNA World and Biogeny 1.2 Evolution of eukaryotes	11
2	**Evolutionary concepts** 2.1 Lamarckism and Neo Lamarckism, Darwinism, Neo-Darwinism, 2.2 Types of Variation – Continuous and discontinuous; heritable and non-heritable. 2.3 Causes, classification and contribution to evolution-Gene mutation; chromosomal aberrations; recombination and random assortment.	15
3	**Evidences of Evolution** 3.1 Types of fossils, geological time scale and climatic conditions and their fauna, 3.2 Evolution of horse. 3.3 Origin and evolution of man; Unique hominid characteristics/primate phylogeny from *Dryopithecus* leading to *Homo sapiens*; Extinctions, Back ground mass extinction (causes and effects, detailed examples: K-T extinction. 3.4 Human migration-theories. Brief reference to molecular analysis of human origin Mitochondrial DNA and Y-chromosome studies.	17
4	**Population Genetics** 4.1 Hardy-weinberg Law 4.2 Natural selection (concept of fitness, types of selection, kin selection) 4.3 Genetic Drift (mechanism, founder's effect, bottleneck phenomenon)	17
	TOTAL	60

Reading List :

1. Ridley, M. (2004). Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
4. Snustad. S Principles of Genetics.
5. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

CC14 : Evolutionary Biology (Practical) (Practical: 2 credits)	
Practical 1.Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of palaeozoic era,Mesozoic era (Archaeopteryx-- a connecting link) 2.Vestigial, Analogous and Homologous organs using suitable specimens. 3. Graphical representation and interpretation of data of height/ weight of a sample of One hundred humans in relation to their age and sex.	30

4.Sampling for discrete characteristics (dominant vs recessive) for discontinuous Variations e.g. hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group) 5.Construction of cladogram or Neo-Darwinian Studies (Calculation of genotypic, phenotypic and allelic frequencies from the data provided). 6.Practical records/ Chart/Model 7.Viva voce	
TOTAL	30

Discipline Specific Elective (DSE)

DSE1 : Animal Behaviour and Chronobiology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To understand various pattern of animal behaviours such as stereotyped, instinct, learnt, associative behaviour along with operant conditioning and habituation imprinting and to explain the concept of social and sexual behaviour.

CO 2- To provide the concept of biological rhythm, photoperiod and regulation of seasonal reproduction of vertebrates and role of melatonin.

CO 3- To understand the relevance of biological clock in terms of chronopharmacology, chronomedicine and chronotherapy.

CO 4- To develop the skill in this course by performing practical works such as studying nest and nesting habitat of birds and social insects and other significant experiments.

DSE1 : Animal Behaviour and Chronobiology (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction to Animal Behaviour** 1.1 Definition of behaviour, Origin and history of Ethology 1.2 Brief profiles of modern ethologists (Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen) 1.3 Proximate and ultimate causes of behaviour	13
2	**Patterns of Behaviour and its Control** 2.1 Stereotyped Behaviour (Orientation, Reflex) 2.2 Instinct behaviours (Kinases/ Taxes, Instinct, motivation); 2.3 Learnt behaviours (Habituation, Imprinting, Conditioned reflexes, Trial and error learning, Latent learning, Reasoning)	15
3	**Chronobiology & Biological Rhythm** 3.1 Biological clocks in animals, Adaptive significance of biological clocks 3.2 Types of biological rhythms- Tidal, Lunar, Circadian and Circannual 3.3 Role of melatonin	15
4	**Social and Sexual Behaviour** 4.1 Social behaviour of insects (Example: Honey bee); Foraging in honey bee and advantage of dance 4.2 Sexual dimorphisms, Mate Choice, Mating systems, Intra-sexual Selection (male rivalry), Inter-sexual selection (female choice) 4.3 Courtship behaviour, Parental care, sexual conflict in parental care	17
	TOTAL	60

Reading List :

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge,University Press, UK.
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
5. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

DSE1 : Animal Behaviour and Chronobiology (Practical) (Practical: 2 credits)		
Unit	**Topics to be covered**	
	Practical : 1. Study of the pattern of Behaviour (any one of the followings) a) Photo Tactile Response in Earthworms or Pest. b) Geotactic Response of Earthworm or Pest. c) Effect of Pollutants or Toxicants on Opercular Movement or General movement or Swimming Pattern of a fish 2. Comment upon the given specimen with response to parental care - Ichthyophis, Hippocampus etc. Trial and Error Learning in Rat 3. Submit and write up on any one of the given topic a) Courtship in Peacock / Pigeons b) Maternal Behavior in Rats / Cats c) Study of nests and nesting behavior of the birds and social insects d) Study of honey bee hive 4. Practical records / Models/ Charts 5. Viva –voce	30
	TOTAL	30

DSE2 : Biology of Insects

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To gain knowledge of pests, classification, morphology and internal systems of plant pests, causes of outbreak of pests, growth and development.

CO 2- To understand concept of agrochemicals, classification of agrochemicals and learn different composting technologies.

CO 3- To gain knowledge of agrochemicals for pest management and their modes of action and their fates in the agro-ecosystem.

CO 4- To explain concept of biopesticides, potential pesticidal plants, plant extracts and bio-organisms and their role in pest control and to learn concept of BT methodology, genetically modified and transgenic plants.

DSE2 : Biology of Insects (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction and Classification** 1.1 General description of insects 1.2 General outline of insect classification	11
2	**Morphology and Physiology** 2.1 Structure and Physiology of Aliementary cana of insects	15

	2.2 Structure and Physiology of Excretory system 2.3 Structure and function of Respiratory system 2.4 Structure and function of Compound Eye of insect 2.5 Structure and function of integument of insect	
3	**Reproductive system and Neuro-endocrine system** 3.1 Male reproductive organs, Testes, Vas deference and Accessing glands. 3.2 Female reproductive organs, ovaries oviducts and Accessory glands 3.3 Neuro- endocrine system, structure and function 3.4 Structure of brain of insect, Protocerebrum, Deutocerebrum and Trytocerebrum	15
4	**Common Pests and insects of medical importance** 4.1 Pests of Paddy: Life history and control measures. 4.2 Pests of Wheat: Life history and control measures. 4.3 Pests of Sugarcane: Life history and control measures. 4.4 Insects of medical importance with their disease of malaria: Biology and control. 4.5 Insects of medical importance with their disease of Kala-azar: Biology and control	19
	TOTAL	60

Reading List :

1. Hill, D.S. (1983) Agricultural insect pests of the tropics and their control- Cambridge Univ. Press.
2. Atwal, A. S. (1979) Agricultural pests of India and south East Asia.
3. Dent, D. (2000) Insect pest management (2nd edition) CAB International.
4. Roberts, D.A. (1978) Fundamentals of Plant Pest Control.
5. De Bach, P. (1964) Biological Control of Insect Pests and Weeds, Chapman & Hall, New York.
6. Koul, O. and Dhaliwal, G.S. (2003) Phytochemical Biopesticides, Harwood Academic Publishers, Amsterdam.
7. Pedigo, L.P. (1996) Entomology and pest management, Prentice Hall, N. Delhi

DSE2 : Biology of Insects (Practical) **(Practical: 2 credits)**	
Topics to be covered	
Practical : 1.Taxonomy and identification of grasshopper , Honey bee, Wasp, Butter fly and moths - 2. Preparation of permanent slides or temporary slides of following (i) Mounth parts (ii) Antennae (iii) Legs (iv) Wings 3. Identify and comment upon : (i) Aquatic insects (ii) Terrestial insects (iii) Stduy of Permanent slides of the wings, Mouthparts, Antennae & legs of insects (iv) Permanent slides of W.M. of small insects (v) study of permanent slides of histology sections of various organs of insects 4. Identification and life history of any one plant insects 5. Field visit for collection and indentification of insects 6. Practical records 7. Viva voce	30
TOTAL	30

DSE3 : Biostatistics

Course Outcomes

After the completion of the course, the student will be able:

CO1: Gain insight of relationship between mathematics and biology
CO2: To present their data in statistically reliable form
CO3: To test their hypothesis using different models
CO4: To correlate their data with different factors

DSE3 : Biostatistics (Theory: 4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction** 1.1 Introduction to biostatistics, concept of data and graphical presentation of data. 1.2 Measures of central tendency: mean, mode and median. 1.3 Measures of dispersion, standard deviation, standard error and variance.	15
2	**Descriptive statistics and Observational study design** 2.1 Types of variables. Multivariate data. 2.2 Experimental design basics, principles of statistical inference and parameter estimation, hypothesis testing. 2.3 Poisson, Binomial and Normal distribution.	15
3	**Tests of Significance** 3.1 Test of significance: t-test, F-test 3.2 Multiple linear regression; ANOVA table for multiple linear regression, assessing model fit polynomials and interactions; One way and two way ANOVA tables.	17
4	**Regression** 4.1 Correlation and simple linear regression 4.2 Karl Pearson correlation coefficient, Spearman rank correlation coefficient.	13
	TOTAL	60

Reading List :

1. AB Khanal (2016). Mahajan's Methods in Biostatistics for Medical Students and Research Workers. Jaypee Brothers Medical Publishers.
2. Jerrold H. Zar (2009). Biostatistical analysis. Pearson publication.
3. RC Elston and WD Johnson (2008). Basic Biostatistics for Geneticists and Epidemiologists. Wiley publication.
4. Norman TJ Bailey (2000). Statistical Methods in Biology. Published by: Cambridge University Press

DSE3 : Biostatistics (Practical) (Practical: 2 credits)	
Topics to be covered	
Practical : 1. Find out the standard deviation & standard error of the data provided. 2. Solve biostatistical problem based on t-test, / F-test 3. Solve biostatistical problem based on chi-square test 4. Find out the value of correlation coefficient /regression of the given set of data 5. Practical records 6. Viva-voce	30
TOTAL	30

DSE4 : Fish Biology

Course Outcomes

After the completion of the course, the student will be able:

CO 1- Understand and apply relevant scientific principles in the area of aquatic biology

CO 2- Employ scientific methodologies such as experimentation and data analysis in the area of aquatic biology

CO 3- Explore some of the unique environmental problems dealing with aquatic environments.

CO 4- Develop employable skills in freshwater biological water quality analysis.

DSE4 : Fish Biology		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction and Classification** 1.1 General description of fish 1.2 General outline of fish classification.	11
2	**Morphology and Physiology** 2.1 Locomotion in fishes 2.2 Types of scales; Application of scales in classification and determination of age of fish 2.3 Gill and gas exchange; Swim Bladder: Types and role in respiration, buoyancy 2.4 Osmoregulation in fish 2.5 Electric organs; Bioluminescence; Schooling; Parental care; Migration.	17
3	**Fisheries** 3.1 Inland fisheries; Fishing crafts and Gears 3.2 Depletion of fisheries resources; Application of remote sensing and GIS in fisheries 3.3 Fisheries law and regulations.	15
4	**Aquaculture** 4.1 Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish 4.2 Pen and Cage culture; Polyculture; Brood stock management; Induced breeding of fish 4.3 Preparation and maintenance of fish aquarium 4.4 Fish disease: Bacterial, viral and parasitic 4.5 Preservation and processing of harvested fish, fishery by-products.	17
	TOTAL	60

Reading list:

1. Goldman, C. (1994) Limnology (2nd edition).

2. Ananthakrishnan, T.N. (1989) Bioresources Ecology (3rd edition).

3. Odum, E.P. and Barrett, G.W. (2004) Fundamentals of Ecology (5th edition).

4. Pawlowski, L. (1980) Physicochemical Methods for water and Wastewater Treatment.

5. Wetzel, R. (2001) Limnology (3rd edition) Elsevier.

6. Trivedy, R.K. and Goyal, P.K. (1986) Chemical and biological methods for water pollution studies.

7. Welch, P.S. (2014) Limnology Vol. I-II.

DSE4 : Fish Biology (Practical) **(Practical: 2 credits)**	
Topics to be covered	
Practical : 1. Taxonomic identification of freshwater fishes based on morphometric and meristic analysis 2. Identify and comment upon: a) Museum specimen (any two): Torpedo, Echeneis, Syngnathus, Exocoetus, Hippocampus b) Permanent slides (any two): Histological sections of various organs, scales in fishes-placoid, cycloid and ctenoid c) Crafts & Gears (any one) 3. Determination of pH, Conductivity, Total dissolved solids, D.O., Total alkalinity. 4. Comment upon ARO in given fish 5. Project Report on a visit to any fish Farm/ Pisciculture unit/ Zebra fish Rearing Lab 6 .Practical Records/ Charts/ Models 7. Viva voce	30
TOTAL	30

DSE5 : Wild life conservation and Management

Course Outcomes

After the completion of the course, the student will be able:

CO 1- To understand different physical and biological parameters for evaluation and management of wildlife.

CO 2- To get the knowledge of Grazing logging, cover construction, preservation of genetic diversity and restoration of degraded habitats under management of habitats.

CO 3- To estimate Population density, Natality, Birth rate, Mortality and fertility schedules.

CO 4- To get the concept of climax persistence, Rescue and rehabilitation, Quarantine, Common disease of wild animal and Man – Animal conflict and to enhance exposure through visit to Wild life Sanctuary, Biodiversity Park and Zoological Parks.

DSE5 : Wild life conservation and Management		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Introduction of wildlife** 1.1 Values of wild life: positive and negative 1.2 Conservation ethics; Importance of conservation; Causes of depletion; Conservation strategies. 1.3 Protected Areas: National parks & sanctuaries, Community reserve; Important features of protected areas in India 1.4 Tiger conservation: Tiger reserves in India; Management challenges in Tiger reserve.ss	15
2	**Evaluation for management of wildlife** 2.1 Habitat analysis, Physical parameters, Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation 2.2 Standard evaluation procedures: remote sensing and GIS. 2.3 Management of habitats: Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction 2.4 Preservation of general genetic diversity; Restoration of degraded habitats	17
3	**Population estimation** 3.1 Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation 3.2 Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.	13
4	**Management planning of wildlife** 4.1 Estimation of carrying capacity; Eco tourism/ wild life tourism in forests; Concept of climax persistence 4.2 Ecology of perturbance, Rescue and rehabilitation; Bio-telemetry; Care of injured and diseased animal; Quarantine 4.3 Common diseases of wild animal, Man-Animal conflict.	15
	TOTAL	60

Reading list:

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,* 5 th 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.

DSE5 : Wild life conservation and Management (Practical) (Practical: 2 credits)	
Topics to be covered	
Practical : 1. Identification of local flora, mammalian fauna, avian fauna, herpeto- fauna. familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. 2. Demonstration of 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, PH meter, Hygrometer, Soil Moisture Meter) 3. Demonstration of different field techniques for flora and fauna a) PCQ, Ten tree method, Circular, Square & rectangular plots, Parker's two Step and other methods of ground cover assessment, Tree cancopy cover assessment, Shrub cover assessment. b) Trail/ transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences) 4. A report based on a visit to National Park/ Wildlife Sanctuary/Biodiversity Park or any other wildlife conservation site. 5. Practical record 6. Viva voce	30
TOTAL	30

General Elective

GE1 : Animal Diversity

Course outcome:

On completion of the course students will be able:

CO1- To understand and describe the features of Protista, Porifera, Radiata, Acoelomates and Pseudocoelomates.

CO2 - To understand and describe the features of Arthropoda, Mollusca and coelomate deuterostomes.

CO3- To understand and describe the features of Protochordates, Pisces and Amphibia.

CO4- To understand and describe the features of Reptiles, Aves and Mammalia.

GE1 : Animal Diversity (Theory :4 credits)		
Unit	**Topics to be covered**	**No. of Lectures**
1	**Protista** General characters of Protozoa; Life cycle of Plasmodium **Porifera** General characters and canal system in Porifera **Radiata** General characters of Cnidarians and polymorphism **Aceolomates** General characters of Helminthes; Life cycle of *Taenia solium* **Pseudocoelomates** General characters of Nemethehelminthes; Parasitic adaptations in Nematodes **Coelomate Protostomes** General characters of Annelida ; Metamerism.	**15**
2	**Arthropoda** General characters. Social life in insects with respect to honey bees and termites	**15**

	Mollusca General characters of mollusca; Pearl Formation **Coelomate Deuterostomes** General characters of Echinodermata, Water Vascular system in Starfish.	
3	**Protochordata Salient features** **Pisces** General Characters, Migration of Fishes, Parental Care **Amphibia** General characters, Adaptations for terrestrial life, Parental care in Amphibia.	**15**
4	Reptiles General Characters, Origin of reptiles **Aves:** General Characters, the origin of birds; Flight adaptations **Mammalia** General Characters, early evolution of mammals; Dentition in mammals.	15
	TOTAL	60

Reading List :

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
4. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

GE1 : Animal Diversity (Practical) **(Practical: 2 credits)**	
Topics to be covered	
Practical : 1. Study of following specimens: **Non Chordates:** *Euglena, Noctiluca, Paramecium, Sycon,, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus,* , Hermitcrab *Daphnia,* Millipede, Centipede, Beetle, *Chiton, Octopus, Asterias, and Antedon.* **Chordates***: Balanoglossus, Amphioxus, Petromyzon Hippocampus, Labeo, Icthyophis Salamander, Draco, Uromastix, Naja, Viper, model of Archaeopteryx,* any three common birds-*(Psittacula, Hen, Sparrow),* Squirrel and Bat. 2. Study of following Permanent Slides: Cross section of Sycon, *Ascaris(*male and female*).* T. S. of Earthworm passing through pharynx, gizzard. Bipinnaria and Pluteus larva 3. Temporary mounts of: Septal & pharyngeal nephridia of earthworm. Stained mounts of Placoid, cycloid and ctenoid scales. 4. Project Report on a biodiversity at any local area 5. Practical Records/ Charts/ Models 6. Viva voce	30
TOTAL	30

GE2 : Environment and Public Health

Course outcome:

On completion of the course students will be able:

CO 1- To acquire knowledge about various sources of environmental hazards, their risk assessment, fate of toxic and persistent substances in the environment.

CO 2- To understand the factors of Climate change like Greenhouse gases, Global warming, Acid rain, Ozone layer destruction and Effect of Climate change on public health.

CO 3- To know about the sources and effects of Air, Water and Noise Pollution and their control methods, Waste Management Technologies, Bhopal Gas Tragedy, Chernobyl Disaster, Seveso Disaster and Three Mile Island Accident and their aftermath.

CO 4- To understand the causes, symptoms and control of Diseases like- Tuberculosis, Asthma, Silicosis, Asbestosis, Cholera, Minamata, Arsenicosis and Fluorosis

GE2 : Environment and Public Health (Theory-4 credits)		
Units	**Topics to be covered**	**Number of hours**
1	**Introduction** Sources of Environmental hazards, hazard identification and risk assessment, fate of toxic and persistent substances in the environment, dose response evaluation	**15**
2	**Climate Change** Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health **Pollution** Air, water, noise pollution sources and effects, Pollution control	15
3	**Waste Management Technologies** Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.	**20**
4	**Diseases** Causes, symptoms and control of tuberculosis, Asthma, Silicosis, Astestosis, Cholera, Minamata, Arsenicosis, Fluorosis	**10**
	TOTAL	**60**

Reading List :

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York,1996.
3. Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.

4. Kasperson, J.X. and Kasperson, R.E. and Kasperson,R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
5. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

GE2 : Environment and Public Health (Practical) (Practical: 2 credits)	
Topics to be covered	
Practical : 1. To determine pH, Cl, NO3 in soil and water samples from different locations. 2. DO in water sample 4. Project Report 5. Practical Records/ Charts/ Models 6. Viva voce	30
TOTAL	30

GE3 : Food, Nutrition and Health

Course outcome:

On completion of the course students will be able:

CO 1- To explain the concept of balanced diet

CO 2- To compare nutrient needs and dietary pattern for various groups – adults, pregnant and nursing mothers.

CO 3- To understand the concept of Carbohydrate, lipids and proteins.

CO 4- To apply the knowledge of potable water and apply to methods of purification at domestic level.

GE3 : Food, Nutrition and Health (Theory-4 credits)		
Units	**Topics to be covered**	**No. of lectures**
1	**Basic concept of food and nutrition** Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly	**15**
2	**Nutritional Biochemistry**: Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions	**15**
3	**Health** Introduction to health- Definition and concept of health Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS)-their causes, treatment and prevention	**20**

	Common ailments- cold, cough, and fevers, their causes and treatment	
4	**Food hygiene**: Potable water- sources and methods of purification at domestic level Food and Water borne infections: **Bacterial infection** Cholera, typhoid fever, dysentery; **Viral infection**: Hepatitis, Poliomyelitis, **Protozoan infection**: amoebiasis, giardiasis; **Parasitic infection**: ascariasis, its transmission, causative agent, sources of infection, symptoms and prevention Brief account of food spoilage: Causes of food spoilage and their preventive measures	**10**
	TOTAL	**60**

Reading List :

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

GE3 : Food, Nutrition and Health (Practical) **(Practical: 2 credits)**	
Topics to be covered	**No. of hours**
1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric 2. Estimation of Lactose in milk 3. Ascorbic acid estimation in food by titrimetry 4. Estimation of Calcium in foods by titrimetry 5. Study of the stored grain pests from slides/ photograph(*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests. 6. Project- Prepare diet chart for different age groups. OR Identify nutrient rich sources of foods **(fruits and vegetables),** their seasonal availability and price- Prepare chart OR Study of nutrition labelling on selected foods 4. Project Report 5. Practical Records/ Charts/ Models 6. Viva voce	30
TOTAL	30

GE4 : Insect Vectors and Diseases

Course outcome:

On completion of the course students will be able:

CO 1- To understand and describe the morphological features of insects

CO 2- To understand the exemplify the important insect Vectors- mosquitoes, Sand fly and houseflies

CO 3- To understand and Explain mosquito-borne diseases live Malaria, Dengue, Chikungunya, Viral encephalitis

CO 4- To understand and describe the Hemipteran disease vectors

GE4: Insect Vectors and Diseases (Theory :4 credits)		
Units	**Topics to be covered**	**No. of lectures**
1	**Introduction to Insects** General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits	**10**
2	**Concept of Vectors** Brief introduction of Carrier and Vectors (mechanical and biological vector),Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity **Insects as Vectors** Insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera	**15**
3	**Dipteran as Disease Vectors** Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly	**20**
4	**Siphonaptera as Disease Vectors** Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas **Hempitera as Disease Vectors** Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	**15**
	TOTAL	**60**

Reading List :

1. Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK
2. Chapman, R.F. (1998). *The Insects: Structure and Function*. IV Edition, Cambridge University Press, UK
3. Pedigo L.P. (2002). *Entomology and Pest Management.* Prentice Hall Publication
4. Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell
5. Peterson P G (2017). *Insect Ecology*. Meditech publication

GE4 : Insect Vectors and Diseases (Pratical) (Practical: 2 credits)	
Topics to be covered	**No. of hours**
1. Study of different kinds of mouth parts of insects 2. Study of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles*, *Musca domestica*, through permanent slides/ photographs 3. Study of different diseases transmitted by above insect vectors **4. Submission of a project report on any one of the insect vectors and disease transmitted** 5. Practical Records/ Charts/ Models 6. Viva voce	30
TOTAL	30

Skill Enhancement Course (SEC)(2Credits)

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide **value-based and/or skill-based knowledge**.

SEC1 : Medical Diagnostics (2 credits)

Course Outcome:

On completion of the course students will be able:

CO 1- To explain various medical diagnostics and their importance.

CO 2- To understand various diagnostics methods used for analysis of blood and urine.

CO 3- To identify infectious diseases and non-infectious diseases, causes, types, symptoms, complications, diagnosis and preventions.

CO 4- To identify and describe tumour types and imaging techniques.

SEC1: Medical Diagnostics (2 credits)		
Unit	**Topics to be covered**	**No. of lectures**
1	Introduction to Medical Diagnostics and its Importance	5
2	**Diagnostics Methods Used for Analysis of Blood :** Blood composition, Preparation of blood smear and Differential Leukocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.) **Diagnostic Methods Used for Urine Analysis :** Urine Analysis: Physical characteristics; Abnormal constituents	**10**
3	**Non-infectious Diseases :**	**10**

	Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit **Infectious Diseases :** Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis	
4	**Tumours :** Type (Benign/Malignant), Detection and metastasis; Medical imaging: X-ray of Bone fracture, PET, MRI and CT Scan (using photographs).	**5**
	TOTAL	**30**

Reading List :

1. Leeuwen AMV, Bladh ML (2017). Davis's Comprehensive Handbook of Laboratory and Diagnostic Tests With Nursing Implications. F.A. Davis Company; 7 edition
2. Buckingham L (2011). Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. F.A. Davis Company; 2 edition
3. Merck Editor (2011). The Merck Manual of Diagnosis and Therapy. Elsevier Health Sciences
4. Captain C, Banerjee P. (2014). Common Laboratory Tests Used by TCM Practitioners : When to Refer Patients for Lab Tests and How to Read and Interpret the Results. Jessica Kingsley Publishers.
5. Andersson D, Creations M (2018). Lab Values: Everything You Need to Know about Laboratory Medicine and its Importance in the Diagnosis of Diseases.

SEC2 : Research Methodology

(2 credits)

Course Outcome:

On completion of the course students will be able:

CO 1- To explain the meaning, objectives and types of research.
CO 2- To formulate research design and plan.
CO 3-To use appropriate sampling methods, analyse data and write report.
CO 4- To understand the ethical issues.

SEC2: Research Methodology (2 credits)		
Unit	**Topics to be covered**	**No. of lectures**
1	**Foundations of Research:** Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied	5
2	**Research Design:** Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs	8
3	**Data Collection, Analysis and Report Writing:** Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology.	12
4	**Ethical Issues:**	5

	Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement	
	TOTAL	30

Reading List :

1. Anthony, M, Graziano, A.M. and Raulin, M.L. (2009). Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Walliman, N. (2011). Research Methods- The Basics. Taylor and Francis, London, New York.
3. Wadhera, B.L.(2002). Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, Universal Law publishing
4. C.R.Kothari (2009). Research Methodology, New Age International.
5. Coley, S.M. and Scheinberg, C.A. (1990). "Proposal writing". Stage Publications.