

# **Syllabus and Structure**

**For**

**B. Sc. ZOOLOGY HONOURS**

*Dibrugarh University*  
*2018*

**Under**

**Choice Based Credit System (CBCS)**

**Passed in the Board of Studies in Life Sciences, Dibrugarh**

**University held on 8<sup>th</sup> April, 2019.**

**SCHEME AND SYLLABUS FOR CHOICE BASED CREDIT SYSTEM  
FOR B.Sc. HONOURS ZOOLOGY**

Semester	Core Course(14)	Ability Enhancement Compulsory Course (2)	Skill Enhancement Course SEC (2)	Discipline Specific Elective DCE (4)	Generic Elective GE (4)
I	Non-chordates I: Protista to Pseudocoelomates	English Communication			GE-1
	Principles of Ecology				
II	Non-chordates II: Coelomates	Environmental Science			GE-2
	Cell Biology				
III	Diversity of Chordates		SEC -1		GE-3
	Physiology: Controlling and Coordinating Systems				
	Fundamentals of Biochemistry				
IV	Comparative Anatomy of Vertebrates		SEC -2		GE-4
	Physiology: Life Sustaining Systems				
	Biochemistry of Metabolic Processes				
V	Molecular Biology			DSE-1	
	Principles of Genetics			DSE-2	
VI	Developmental Biology			DSE -3	,
	Evolutionary Biology			DSE-4	

Semester	Course Code	Course	Course Name	Credits
I		Ability Enhancement Compulsory Course-I	English communications	2
			Environmental Science	
	ZC101T	Core course-I	Non-chordates I: Protista to Pseudocoelomates	4
	ZC101P	Core Course-I (Practical)		2
	ZC102T	Core course-II	Principles of Ecology	4
	ZC102P	Core Course-II (Practical)		2
	ZG101T	Generic Elective -1	GE-1	4
ZG101P	Generic Elective -1 Practical/Tutorial		2	
II		Ability Enhancement Compulsory Course-II	English communications/ Environmental Science	2
	ZC203T	Core course-III	Non-chordates II: Coelomates	4
	ZC203P	Core Course-III (Practical)		2
	ZC204T	Core course-IV	Cell Biology	4
	ZC204P	Core Course-IV (Practical)		2
	ZG202T	Generic Elective -2	GE-2	4
	ZG202P	Generic Elective -2 (Practical)		2
III	ZC305T	Core course-V	Diversity of chordates	4
	ZC305P	Core Course-V (Practical)		2
	ZC306T	Core course-VI	Physiology: Controlling and Coordinating systems	4
	ZC306P	Core Course-VI (Practical)		2
	ZC307T	Core course-VII	Fundamentals of Biochemistry	4
	ZC307P	Core Course-VII (Practical)		2
	ZS301	Skill Enhancement Course-1	<b>SEC-1: Any one course from I to III</b> I. Apiculture II. Medical Diagnostic III. Sericulture	4
	ZG303T	Generic Elective -3	GE-3	4
	ZG303P	Generic Elective -3 (Practical)		2
IV	ZC408T	Core course-VIII	Comparative anatomy of vertebrates	4
	ZC408P	Course-VIII (Practical)		2
	ZC409T	Core course-IX	Physiology: Life Sustaining Systems	4
	ZC409P	Course-IX (Practical)		2
	ZC410T	Core course-X	Biochemistry of Metabolic Processes	4
	ZC410P	Core Course- X (Practical)		2
	ZS402	Skill Enhancement Course-2	<b>SEC-2: Any one course from IV to V</b> IV. Aquarium Fish Keeping V. Research Methodology	4
	ZG404T	Generic Elective -4	GE-4	4
	ZG404P	Generic Elective -4 (Practical)		2
V	ZC511T	Core course-XI	Molecular Biology	4
	ZC511P	Core Course-XI (Practical)		2
	ZC512T	Core course-XII	Principles of Genetics	4
	ZC512P	Core Course-XII (Practical)		2

**Discipline Specific Elective: Students may opt any two of the following courses (Two Theory courses along with relevant Practical courses)**

	ZD501T	Discipline Specific Elective -1	DSE-1: Animal Behaviour and Chronobiology	4	
	ZD501P	Discipline Specific Elective- 1 (Practical/Tutorial)		2	
	ZD502 T	Discipline Specific Elective-2	DSE 2: Computational Biology	4	
	ZD502P	Discipline Specific Elective- 2 (Practical)		2	
	ZD503T	Discipline Specific Elective-3	DSE 3: Endocrinology	4	
	ZD503P	Discipline Specific Elective- 3 (Practical)		2	
	ZD504T	Discipline Specific Elective-4	DSE 4: Biology of Insecta	4	
	ZD504P	Discipline Specific Elective-4 (Practical)		2	
	ZD 505T	Discipline Specific Elective-5	DSE 5: Basics of Neuroscience	4	
	ZD505P	Discipline Specific Elective-5 (Practical)		2	
VI	ZC613T	Core course-XIII	Developmental Biology	4	
	ZC613P	Core Course-XIII (Practical/Tutorial)		2	
	ZC614T	Core course-XIV	Evolutionary Biology	4	
	ZC614P	Core Course-XIV (Practical/Tutorial)		2	
	<b>Discipline Specific Elective: Students may opt any two of the following courses (Two Theory courses along with relevant Practical courses)</b>				
	ZD606T	Discipline Specific Elective -6	DSE-6: Animal Biotechnology	4	
	ZD606P	Discipline Specific Elective -6 (Practical/Tutorial)		2	
	ZD607T	Discipline Specific Elective-7	DSE-7: Fish and Fisheries	4	
	ZD607P	Discipline Specific Elective -7 (Practical/Tutorial)		2	
	ZD608T	Discipline Specific Elective-8	DSE-8: Immunology	4	
	ZD608P	Discipline Specific Elective -8 (Practical/Tutorial)		2	
	ZD609T	Discipline Specific Elective-9	DSE-9: Parasitology	4	
	ZD609P	Discipline Specific Elective -9 (Practical/Tutorial)		2	
ZD610T	Discipline Specific Elective-10	DSE-10: Reproductive Biology	4		
ZD610P	Discipline Specific Elective -10 (Practical/Tutorial)		2		
ZD611T	Discipline Specific Elective-11	DSE-11: Wild Life Conservation and Management	4		
ZD611P	Discipline Specific Elective -11 (Practical/Tutorial)		2		
				<b>140</b>	

**Coding pattern: Z = Zoology, C= Core Course, D = Discipline Specific Elective, G= General Elective, S = Skill Enhancement Course, T = Theory, P = Practical**

<b>CORE COURSES</b>	
<b>CC I</b>	Non-chordates I: Protista to Pseudocoelomates
<b>CC II</b>	Perspectives in Ecology
<b>CC III</b>	Non-chordates II: Coelomates
<b>CC IV</b>	Cell Biology
<b>CC V</b>	Diversity of Chordates
<b>CC VI</b>	Physiology: Controlling and Coordinating Systems
<b>CC VII</b>	Fundamentals of Biochemistry
<b>CC VIII</b>	Comparative Anatomy of Vertebrates
<b>CC IX</b>	Physiology: Life Sustaining Systems
<b>CC X</b>	Biochemistry of Metabolic Processes
<b>CC XI</b>	Molecular Biology
<b>CC XII</b>	Principles of Genetics
<b>CC XIII</b>	Developmental Biology
<b>CC XIV</b>	Evolutionary Biology

<b>DISCIPLINE SPECIFIC ELECTIVE COURSES</b>	
<b>DSE I</b>	Animal Behaviour and Chronobiology
<b>DSE II</b>	Computational Biology
<b>DSE III</b>	Endocrinology
<b>DSE IV</b>	Biology of Insecta
<b>DSE V</b>	Basics of Neuroscience
<b>DSE VI</b>	Animal Biotechnology
<b>DSE VII</b>	Fish and Fisheries
<b>DSE VIII</b>	Immunology
<b>DSE IX</b>	Parasitology
<b>DSE X</b>	Reproductive Biology
<b>DSE XI</b>	Wild Life Conservation and Management

<b>GENERIC ELECTIVE COURSES</b>	
<b>GE I</b>	Animal Cell Biotechnology
<b>GE II</b>	Animal Diversity
<b>GE III</b>	Aquatic Biology
<b>GE IV</b>	Environment and Public Health
<b>GE V</b>	Exploring the Brain: Structure and Function
<b>GE VI</b>	Food, Nutrition and Health
<b>GE VII</b>	Human Physiology
<b>GE VIII</b>	Insect Vectors and Diseases

<b>SKILL ENHANCEMENT COURSES</b>	
<b>SEC I</b>	Apiculture
<b>SEC II</b>	Medical Diagnostics
<b>SEC III</b>	Sericulture
<b>SEC IV</b>	Aquarium Fish Keeping
<b>SEC V</b>	Research Methodology

**Course Code: ZC101T****CORE COURSE I: NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES**

*\*The objective of the course is to expose the students to various forms of protozoa and worms; their classification and structural anatomy.*

**THEORY**

**(Credits 4)  
(Total Lectures=60)**

**Unit 1: Protista, Parazoa and Metazoa****19 Lectures**

General characteristics and Classification up to Classes

Structural organization & nutrition of *Euglena*, *Amoeba* and *Paramecium*

Life cycle and pathogenicity of *Plasmodium vivax*

Locomotion and Reproduction in Animal protista

(Protozoa) Evolution of symmetry and segmentation of Metazoa

**Unit 2: Porifera****7 Lectures**

General characteristics and Classification up to classes

Canal system and spicules in sponges

**Unit 3: Cnidaria****12 Lectures**

General characteristics and Classification up to classes

Metagenesis in *Obelia*

Polymorphism in Cnidaria

Corals and coral reefs

**Unit 4: Ctenophora****4 Lectures**

General characteristics and Evolutionary significance

**Unit 5: Platyhelminthes****10 Lectures**

General characteristics and Classification up to classes

Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*

**Unit 6: Nematelminthes****8 Lectures**

General characteristics and Classification up to classes

Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*

Parasitic adaptations in helminthes

**Note:** Classification to be followed from –Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition  
Question to be set giving weightage in proportion to the number of class shown against each unit.

**Course Code: ZC101P**

**NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES**

**PRACTICALS**

**(Credits 2)**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in Animal protista (Protozoa)
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
4. Identification of museum specimen: *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora* and One specimen/slide of any ctenophore
5. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro-photographs)
6. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
7. To submit a Project Report on any related topic based on theory syllabus.

**Note:** Classification to be followed from –Ruppert and Barnes (2006) *Invertebrate Zoology*, 8<sup>th</sup> edition, Holt Saunders International Edition

**SUGGESTED READINGS**

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- 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
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson



**Course Code: ZC102T**

**CORE COURSE II:**

**PRINCIPLES OF**

**ECOLOGY**

*\*The objective of the course is to familiarize the students with fundamentals of ecology and impacts of ecological factors on living organisms.*

**THEORY**

**(Credits 4)  
(Lectures=60)**

**Unit 1: Introduction to Ecology**

**6 Lectures**

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of abiotic factors

**Unit 2: Population**

**24 Lectures**

Unitary and Modular populations

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

**Unit 3: Community**

**12 Lectures**

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with hydrosere Theories pertaining to climax community

**Unit 4: Ecosystem**

**14 Lectures**

Types of ecosystems with one example in detail (Forest ecosystem), Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies

Nutrient and biogeochemical cycle with Nitrogen cycle as an example

Human modified ecosystem

**Unit 5: Applied Ecology**

**4 Lectures**

Concept of wildlife conservation (Usefulness, causes and consequences of degradation); Management strategies

**Course Code: ZC102P**  
**PRINCIPLES OF ECOLOGY**

**PRACTICALS**

**(Credits 2)**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO<sub>2</sub>
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/Reserved forest

**SUGGESTED READINGS**

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

**Course Code: ZC203T**

**CORE COURSE III**

**NON-CHORDATES II: COELOMATES**

*\*The objective of the course is to expose the students to various forms of coelomates, their classification and structural anatomy*

**THEORY**

**(Credits 4)  
(Lectures=60)**

**Unit 1: Introduction to Coelomates**

**2 Lectures**

Evolution of coelom and metamerism

**Unit 2: Annelida**

**10 Lectures**

General characteristics and Classification up to classes  
Excretion in Annelida

**Unit 3: Arthropoda**

**17 Lectures**

General characteristics and Classification up to classes  
Vision and Respiration in Arthropoda  
Metamorphosis in Insects  
Social life in bees and termites

**Unit 4: Onychophora**

**4 Lectures**

General characteristics and Evolutionary significance

**Unit 5: Mollusca**

General characteristics and Classification up to classes  
Respiration in Mollusca  
Torsion and detorsion in Gastropoda  
Pearl formation in bivalves  
Evolutionary significance of trochophore larva

**Unit 6: Echinodermata**

**12 Lectures**

General characteristics and Classification up to classes  
Water-vascular system in Asteroidea  
Larval forms in  
Echinodermata Affinities  
with Chordates

**Note:** Classification to be followed from –Ruppert and Barnes (2006) *Invertebrate Zoology*, 8<sup>th</sup> edition, Holt Saunders International Edition

**Course Code: ZC203P**

**N  
PRACTICAL  
O**

**(Credits 2)**

**N-CHORDATES II: COELOMATES**

1. Study of following specimens:  
Annelids - *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*,  
*Pheretima*, *Hirudinaria*  
Arthropods - *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*,  
*Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta*, termites and honey  
bees Onychophora - *Peripatus*  
Molluscs - *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Pinctada*, *Sepia*,  
*Octopus*, *Nautilus*  
Echinodermates - *Pentaceros/Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Cucumaria* and  
*Antedon*
2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
4. Mount of mouth parts and dissection of digestive system and nervous system of  
*Periplaneta*\*
5. To submit a Project Report on any related topic to larval forms (crustacean,  
mollusc and echinoderm)

**Note:** Classification to be followed from –Ruppert and Barnes (2006) *Invertebrate Zoology*, 8<sup>th</sup> edition, Holt Saunders International Edition

**SUGGESTED READINGS**

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
- 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
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

**Course Code: ZC204T**

**CORE COURSE IV CELL BIOLOGY**

*\*The objective of the course is to expose the students to structure and function of a cell as the fundamental unit of life.*

<b>THEORY</b>	<b>(Credits 4) (Lectures=60)</b>
<b>Unit 1: Overview of Cells</b>	<b>3 Lectures</b>
Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions	
<b>Unit 2: Plasma Membrane</b>	<b>7 Lectures</b>
Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions	
<b>Unit 3: Endomembrane System</b>	<b>10 Lectures</b>
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	
<b>Unit 4: Mitochondria and Peroxisomes</b>	<b>8 Lectures</b>
Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes	
<b>Unit 5: Cytoskeleton</b>	<b>8 Lectures</b>
Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	
<b>Unit 6: Nucleus</b>	<b>12 Lectures</b>
Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)	
<b>Unit 7: Cell Division</b>	<b>8 Lectures</b>
Mitosis, Meosis, Cell cycle and its regulation	
<b>Unit 8: Cell Signaling</b>	<b>4 Lectures</b>
GPCR and Role of second messenger (cAMP)	

**Course Code: ZC204P**  
**CELL BIOLOGY**

**PRACTICAL**

**(Credits 2)**

1. Preparation of temporary stained squash of any suitable material to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
  - i. DNA by Feulgen reaction
  - ii. DNA and RNA by MGP
  - iii. Mucopolysaccharides by PAS reaction
  - iv. Proteins by Mercurobromophenol blue/Fast Green

**SUGGESTED READINGS**

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- 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.
- 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.
- 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.

**Course Code: ZC305T****CORE COURSE V: DIVERSITY OF CHORDATA**

*\*The objective of the course is to expose the students to various forms of chordates, their classification and structural anatomy.*

**THEORY****(Credits 4)****(Lectures=60)****Unit 1: Introduction to Chordates****2 Lectures**

General characteristics and outline classification

**Unit 2: Protochordata****8 Lectures**

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata

**Unit 3: Origin of Chordata****3 Lectures**

Dipleurula concept and the Echinoderm theory of origin of chordates  
Advanced features of vertebrates over Protochordata

**Unit 4: Agnatha****2 Lectures**

General characteristics and classification of cyclostomes up to class

**Unit 5: Pisces****8 Lectures**

General characteristics of Chondrichthyes and Osteichthyes, classification up to order Migration, Osmoregulation and Parental care in fishes

**Unit 6: Amphibia****6 Lectures**

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians

**Unit 7: Reptilia****7 Lectures**

General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes

**Unit 8: Aves****8 Lectures**

General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds

**Unit 9: Mammals****8 Lectures**

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

**Unit 10: Zoogeography****8 Lectures**

Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

**Course Code: ZC305P**

**DIVERSITY OF CHORDATA**

**PRACTICAL**

**(Credits 2)**

**1. Identification :**

**(i) Protochordata**

*Balanoglossus, Herdmania, Branchiostoma*, Colonial Urochordata Sections of *Balanoglossus* through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania* spicules

**(ii) Agnatha**

*Petromyzon, Myxine*

**(iii) Fishes**

*Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetradon/ Diodon, Anabas*, Flat fish

**(iv) Amphibia**

*Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra*

**(v) Reptilia**

*Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*  
Key for Identification of poisonous and non-poisonous snakes

**(vi) Aves**

Study of six common birds from different orders. Types of beaks and claws

**(vii) Mammalia**

*Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous*.

2. Dissection of weberian ossicles of *Mystus*, pecten from Fowl head

3. Dissection of Fowl head (Dissections and mounts subject to permission)

Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

4. To study and prepare a chart of keys of identification of poisonous and non-poisonous snakes.

Classification from Young, J. Z. (2004) to be followed

**SUGGESTED READINGS**

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





**Course Code: ZC306T**

**CORE COURSE VI:**

**ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS**

*\*The objective of this course is to provide a foundation for understanding the complexities of the coordination system of animal body.*

**THEORY**

**(Credits 4)  
(Lectures=60)**

**Unit 1: Tissues**

**6 Lectures**

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

**Unit 2: Bone and Cartilage**

Structure and types of bones and cartilages, Ossification, bone growth and resorption

**Unit 3: Nervous System**

**10 Lectures**

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.

**Unit 4: Muscle**

**12 Lectures**

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 and tetanus

**Unit 5: Reproductive System**

**10 Lectures**

Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female

**Unit 6: Endocrine System**

**18 Lectures**

Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones



**Course Code: ZC306P**

**ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS**

**PRACTICALS**

**(Credits 2)**

- \*1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues

(\*Subject to UGC guidelines)

**SUGGESTED BOOKS**

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Course Code: ZC307T

CORE COURSE VII:

**FUNDAMENTALS OF BIOCHEMISTRY**

*\*The objective of this course is to expose the students to biomolecules of living organisms, their interactions for perpetuation of life.*

**THEORY****(CREDITS 4)  
(Lectures=60)****Unit 1: Carbohydrates****8 Lectures**

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

**Unit 2: Lipids****8 Lectures**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

**Unit 3: Proteins****14 Lectures**

**Amino acids:** Structure, Classification and General properties of  $\alpha$ -amino acids; Physiological importance of essential and non-essential  $\alpha$ -amino acids

**Proteins:** Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins

**Immunoglobulins:** Basic Structure, Classes and Function, Antigenic Determinants

**Unit 4: Nucleic Acids****12 Lectures**

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids  
Cot Curves: Base pairing, Denaturation and Renaturation of DNA  
Types of DNA and RNA, Complementarity of DNA, Hypo-Hyperchromaticity of DNA

**Unit 5: Enzymes****18 Lectures**

Nomenclature and classification; Cofactors; Specificity of action; enzymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of  $K_m$  and  $V_{max}$ , Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes, Isozymes; Regulation of enzyme action.



**Course Code: ZC307P**  
**FUNDAMENTALS OF BIOCHEMISTRY**

**PRACTICAL**

**(CREDITS 2)**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase.
5. Demonstration of proteins separation by SDS-PAGE (theoretically).

**SUGGESTED READING**

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.



**Course Code: ZC408T**

**CORE COURSE VIII: COMPARATIVE ANATOMY OF VERTEBRATES**

<b>THEORY</b>	<b>(CREDITS 4) (Lectures=60)</b>
<b>Unit 1: Integumentary System</b> Structure, functions and derivatives of integument	<b>8 Lectures</b>
<b>Unit 2: Skeletal System</b> Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	<b>8 Lectures</b>
<b>Unit 3: Digestive System</b> Alimentary canal and associated glands, dentition	<b>8 Lectures</b>
<b>Unit 4: Respiratory System</b> Skin, gills, lungs and air sacs; Accessory respiratory organs	<b>8 Lectures</b>
<b>Unit 5: Circulatory System</b> General plan of circulation, evolution of heart and aortic arches	<b>8 Lectures</b>
<b>Unit 6: Urinogenital System</b> Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	<b>6 Lectures</b>
<b>Unit 7: Nervous System</b> Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals	<b>8 Lectures</b>
<b>Unit 8: Sense Organs</b> Classification of receptors Brief account of visual and auditory receptors in man	<b>6 Lectures</b>



**Course Code: ZC408P**

**COMPARATIVE ANATOMY OF VERTEBRATES**

**PRACTICAL**

**(CREDITS 2)**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit
3. Mammalian skulls: One herbivorous and one carnivorous animal
4. Dissection of fish (carp) to study efferent and afferent branchial system(subject to permission)
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)

**SUGGESTED READINGS**

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



**Course Code: ZC409T**

**CORE COURSE IX:**

**ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**

**THEORY**

**(Credits 4)  
(Lectures=60)**

**Unit 1: Physiology of Digestion**

**14 Lectures**

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract.

**Unit 2: Physiology of Respiration**

**12 Lectures**

Histology of trachea and lung; Mechanism of respiration, pulmonary ventilation; Respiratory volumes and capacities; Respiratory pigments, Transport of oxygen and carbon dioxide in blood; Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration

**Unit 3: Renal Physiology**

**8 Lectures**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

**Unit 4: Blood**

**14 Lectures**

Components of blood and their functions; Structure and functions of haemoglobin Haemostasis: Blood clotting system, Kallikrein-Kininogen system, Complement system& Fibrinolytic system, Haemopoiesis Blood groups: Rh factor, ABO and MN

**Unit 5: Physiology of Heart**

**12 Lectures**

Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation



**Course Code: ZC409P**

**ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**

**PRACTICALS**

**(CREDITS 2)**

1. Determination of ABO Blood group and Rh factor
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of frog's heart beat under *in situ* and perfused conditions\*
6. Recording of blood pressure using a sphygmomanometer
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

(\*Subject to UGC guidelines)

**SUGGESTED READINGS**

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





**Course Code: ZC410T**

**CORE COURSE X:**

**BIOCHEMISTRY OF METABOLIC PROCESSES**

**THEORY**

**(CREDITS 4)  
(Lectures=60)**

**Unit 1: Overview of Metabolism**

**10 Lectures**

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; basics of intermediary metabolism and overview of regulatory strategies

**Unit 2: Carbohydrate Metabolism**

**16 Lectures**

Sequence of reactions and pathways of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

**Unit 3: Lipid Metabolism**

**14 Lectures**

$\beta$ -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

**Unit 4: Protein Metabolism**

**10 Lectures**

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

**Unit 5: Oxidative Phosphorylation**

**10 Lectures**

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System



**Course Code: ZC410P**  
**BIOCHEMISTRY OF METABOLIC PROCESS**

**PRACTICALS**

**(CREDITS 2)**

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
5. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO<sub>2</sub> in the TCA cycle

**SUGGESTED READINGS**

- Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.



**Course Code: ZC511T**  
**CORE COURSE XI:**  
**MOLECULAR BIOLOGY**

<b>THEORY</b>	<b>(CREDITS 4)</b>
	<b>(Lectures=60)</b>
<b>Unit 1: Nucleic Acids</b>	<b>4 Lectures</b>
Salient features of DNA and RNA Watson and Crick model of DNA	
<b>Unit 2: DNA Replication</b>	<b>12 Lectures</b>
DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear <i>ds</i> -DNA,	
<b>Unit 3: Transcription</b>	<b>10 Lectures</b>
RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors	
<b>Unit 4: Translation</b>	<b>12 Lectures</b>
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation	
<b>Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA</b>	<b>6 Lectures</b>
Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA	
<b>Unit 6: Gene Regulation</b>	<b>10 Lectures</b>
Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from <i>lac</i> operon and <i>trp</i> operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting	
<b>Unit 7: DNA Repair Mechanisms</b>	<b>3 Lectures</b>
Pyrimidine dimerization and mismatch repair	
<b>Unit 8: Regulatory RNAs</b>	<b>3 Lectures</b>
Concept of Ribo-switches, RNA interference, miRNA, siRNA	



**Course Code: ZC511P**  
**MOLECULAR BIOLOGY**

**PRACTICAL**

**(CREDITS 2)**

1. Study of Polytene chromosomes from Chironomous / *Drosophila* larvae
2. Preparation of liquid culture medium (LB) and inoculation
3. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking
4. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent)
5. Quantitative estimation of RNA using Orcinol reaction
6. Study and interpretation of electron micrographs/ photograph showing
  - (a) DNA replication
  - (b) Transcription
  - (c) Split genes

**SUGGESTED READINGS**

- 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.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.



**Course Code: ZC512T**

**CORE COURSE XII: PRINCIPLES OF GENETICS**

**THEORY**

**(CREDITS 4)  
(Lectures=60)**

**Unit 1: Mendelian Genetics and its Extension**

**8 Lectures**

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.

**Unit 2: Linkage, Crossing Over and Chromosomal Mapping**

**12 Lectures**

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

**Unit 3: Mutations**

**10 Lectures**

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

**Unit 4: Sex Determination**

**4 Lectures**

Chromosomal mechanisms of sex determination in *Drosophila* and Man

**Unit 5: Extra-chromosomal Inheritance**

**6 Lectures**

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects

**Unit 6: Polygenic Inheritance**

**3 Lectures**

Polygenic inheritance with suitable examples; simple numericals based on it.

**Unit 7: Recombination in Bacteria and Viruses**

**9 Lectures**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

**Unit 8: Transposable Genetic Elements**

**8 Lectures**

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans



**Course Code: ZC512P**  
**PRINCIPLES OF GENETICS**

**PRACTICALS**

**(CREDITS 2)**

1. To study the Mendelian laws and gene interactions (based on theory)
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation, transformation and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal) based on data.
6. Pedigree analysis of some human inherited traits.

**SUGGESTED READINGS**

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.



**Course Code: ZC613T**  
**CORE COURSE XIII:**  
**DEVELOPMENTAL BIOLOGY**

<b>THEORY</b>	<b>(CREDITS 4)</b> <b>(Lectures=60)</b>
<b>Unit 1: Introduction</b>	<b>4 Lectures</b>
Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	
<b>Unit 2: Early Embryonic Development</b>	<b>28 Lectures</b>
Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers	
<b>Unit 3: Late Embryonic Development</b>	<b>8 Lectures</b>
Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	
<b>Unit 4: Post Embryonic Development</b>	<b>12 Lectures</b>
Metamorphosis: Changes in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories	
<b>Unit 5: Implications of Developmental Biology</b>	<b>8 Lectures</b>
Teratogenesis: Teratogenic agents and their effects on embryonic development; <i>In vitro</i> fertilization, Stem cell (ESC), Amniocentesis	



**Course Code: ZC613P**  
**DEVELOPMENTAL BIOLOGY**

**PRACTICALS**

**(CREDITS 2)**

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), 21, 24, 28, 33, 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 (photomicrograph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

**SUGGESTED READINGS**

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



Course Code: ZC614T

CORE COURSE XIV:

**EVOLUTIONARY BIOLOGY****THEORY****(CREDITS 4)****(Lectures=60)****Unit 1:****7 Lectures**

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes

**Unit 2:****4 Lectures**

Historical review of evolutionary concept: Lamarckism, Darwinism, Neo- Darwinism

**Unit 3:****10 Lectures**

Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, three domains of life, neutral theory of molecular evolution, molecular clock ,example of globin gene family

**Unit 4:****8 Lectures**

Sources of variations: Heritable variations and their role in evolution

**Unit 5:****13 Lectures**

Basic concept of Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, mechanism of working, types of selection, density- dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

**Unit 6:****7 Lectures**

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches

**Unit 7:****2 Lectures**

Extinctions; Back ground and mass extinctions (causes and effects), detailed example of K-T extinction

**Unit 8:****6 Lectures**

Origin and evolution of man; Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin

**Unit 9:****2 Lectures**

Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

**Course Code: ZC614P**  
**EVOLUTIONARY BIOLOGY**

**PRACTICALS**

**(CREDITS 2)**

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

**SUGGESTED READINGS**

- Ridley, M (2004) Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Snustad. S Principles of Genetics.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley- Blackwell

## DISCIPLINE CENTRIC ELECTIVE COURSES

Course Code: ZD501T

DSE Course I:

### ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

#### THEORY

(Credits 4)

(Lectures=60)

#### Unit 1: Introduction to Animal Behavior

7 Lectures

Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behavior.

#### Unit 2: Patterns of Behaviour

10 Lectures

Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

#### Unit 3: Social and Sexual Behaviour

14 Lectures

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

#### Unit 4: Introduction to Chronobiology

9 Lectures

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks

#### Unit 5: Biological Rhythm

13 Lectures

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

#### Unit 8: Biological Clocks

7

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

**Course Code: ZD501P**

**ANIMAL BEHAVIOUR AND CHRONOBIOLOGY**

**PRACTICAL**

**(Credits 2)**

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

**SUGGESTED READINGS**

- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.)R.D. Lewis. (3<sup>rd</sup> Ed) 2002 Baren and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

**Course Code: ZD502T**

**DSE Course: II COMPUTATIONAL BIOLOGY**

<b>THEORY</b>	<b>(Credits 4) (Lectures=60)</b>
<b>Unit 1: Introduction to Bioinformatics</b>	<b>5 Lectures</b>
Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics	
<b>Unit 2: Biological Databases</b>	<b>10 Lectures</b>
Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)	
<b>Unit 3: Data Generation and Data Retrieval</b>	<b>14 Lectures</b>
Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	
<b>Unit 3: Basic Concepts of Sequence Alignment</b>	<b>14 Lectures</b>
Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.	
<b>Unit 4: Applications of Bioinformatics</b>	<b>7 Lectures</b>
Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome- wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)	
<b>Unit 5: Biostatistics</b>	<b>10 Lectures</b>
Introduction, calculation of standard deviation, standard error, Co-efficient of Variance, Chi-square test, Z test, t-Test	

**Course Code: ZD502P**  
**COMPUTATIONAL BIOLOGY**

**PRACTICAL (Credits 2)**

1. Accessing biological databases
2. Retrieval of nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST) and interpret the output
4. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences
5. Predict the structure of protein from its amino acid sequence by using homology modeling technique
6. To perform a –two-sample t- testl for a given set of data
7. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

**SUGGESTED READINGS**

- Ghosh Z and Mallick B. (2008). *Bioinformatics: Principles and Applications*, Oxford University Press.
- Pevsner J. (2009). *Bioinformatics and Functional Genomics*, II Edition, Wiley Blackwell.
- Zvelebil, Marketa and Baum O. Jeremy (2008). *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, USA.
- Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA
- Antonisamy, B., Christopher S. and Samuel, P. P. (2010). *Biostatistics: Principles and Practice*. Tata McGraw Hill Education Private Limited, India.
- Pagana, M. and Gavreau, K. (2000). *Principles of Biostatistics*, Duxberry Press, USA

**Course Code: ZD503T**  
**DSE Course III:**  
**ENDOCRINOLOGY**

**THEORY**

**(Credits 4)**

**(Lectures=60)**

**Unit 1: Introduction to Endocrinology**

**12 Lectures**

History of endocrinology, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones

**Unit 2: Epiphysis, Hypothalamo-hypophysial Axis**

**15 Lectures**

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.

Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms

Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland.

**Unit 3: Peripheral Endocrine Glands**

**18 Lectures**

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis

**Unit 4: Regulation of Hormone Action**

**15 Lectures**

Hormone action at Cellular level and molecular level:

Hormone receptor : signal transducer, second messenger  
Hormones in homeostasis, Disorders of endocrine glands

**Course Code: ZD503P**  
**ENDOCRINOLOGY**

**PRACTICAL**

**(Credits 2)**

1. Dissect and display of Endocrine glands in laboratory bred (virtual) rat\*
2. Study of the permanent slides of all the endocrine glands
3. Study of estrus cycle in bred rat\*
4. Demonstration of Castration/ ovariectomy in laboratory bred rat\*

\* **Subject to UGC guidelines**

**SUGGESTED READINGS**

- General Endocrinology C. Donnell Turner Pub- Saunders Toppan
- Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead.
- Oxford: BIOS Scientific Publishers; 2001.
- Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
- Vertebrate Endocrinology by David O. Norris,



**Course Code: ZD504T**  
**DSE Course IV: BIOLOGY OF INSECTA**

<b>THEORY</b>	<b>(Credits 4)</b> <b>(Lectures=60)</b>
<b>Unit I: Introduction</b>	<b>4 Lectures</b>
General Features of Insects	
Distribution and Success of Insects on the Earth	
<b>Unit II: Insect Taxonomy</b>	<b>4 Lectures</b>
Basis of insect classification; Classification of insects up to orders	
<b>Unit III: General Morphology of Insects</b>	<b>8 Lectures</b>
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits	
Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat	
Abdominal appendages and genitalia	
<b>Unit IV: Physiology of Insects</b>	<b>28 Lectures</b>
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine and reproductive.	
Sensory receptors and nervous system	
Growth and metamorphosis	
<b>Unit IV: Insect Society</b>	<b>6 Lectures</b>
Group of social insects and their social life	
Social organization and social behaviour (w.r.t. any one example)	
<b>Unit V: Insect Plant Interaction</b>	<b>4 Lectures</b>
Theory of co-evolution, role of allelochemicals in host plant mediation	
Host-plant selection by phytophagous insects, Insects as plant pests	
<b>Unit VI: Insects as Vectors</b>	<b>6 Lectures</b>
Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors	

**Course Code: ZD504P**  
**BIOLOGY OF INSECTA**

**PRACTICAL**

**(CREDITS 2)**

1. Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of head and sclerites of any one insect
4. Study of insect wings and their venation.
5. Prepare permanent slide of insect spiracles
6. Methodology of collection, preservation and identification of insects.
7. Morphological studies of various castes of *Apis*, and *Odontotermes*
8. Study of any three insect pests and their damages
9. Study of any three beneficial insects and their products

**Field study of insects and submission of a project report on the insect diversity**

**SUGGESTED READINGS**

- A general text book of entomology, Imms , A. D., Chapman & Hall, UK
- The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
- Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
- The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
- Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
- Physiological system in Insects, Klowden, M. J., Academic Press, USA
- The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
- Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

**Course Code: ZD505T**  
**DSE Course V:**  
**BASICS OF NEUROSCIENCE**

**THEORY**

**(Credits 4)**

**(Lectures=60)**

**Unit 1: Introduction to Neuroscience**

**6 Lectures**

Origins of Neuroscience; Neuroanatomy, Neurophysiology, and Systems Neurobiology

**UNIT 2: The Nervous system-An Introduction**

**14 Lectures**

Introduction to the structure and function of the nervous system: Cellular components: Neurons; Neuroglia; Neuron doctrine; The prototypical neuron – axons and dendrites as unique structural components of neurons. The ionic bases of resting membrane potential; The action potential- its generation and properties; The action potential conduction.

**UNIT 3: Cellular and Molecular Neurobiology**

**14 Lectures**

Molecular and cellular approaches used to study the CNS at the level of single molecules, Synapse: Synaptic transmission, Principles of synaptic integration; EPSPs and IPSPs. Ion channels, Neural transmission,

**Unit 4. Neurotransmitters**

**10 Lectures**

Different types of neurotransmitters– catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors.

**UNIT 5: Neurobiology and Neuropharmacology of Behaviour**

**16 Lectures**

The principles of signal transduction and information processing in the vertebrate central nervous system, and the relationship of functional properties of neural systems with perception and behavior; sensory systems, molecular basis of behavior including learning and memory. Molecular pathogenesis of pain and neurodegenerative diseases such as Parkinson's, Alzheimer's, psychological disorders, addiction.

**Course Code: ZD505P**  
**BASICS OF NEUROSCIENCE**

**PRACTICAL**

**(CREDITS 2)**

1. Nerve Cell preparation from the spinal cord.
2. Study of neurons and/ or myelin by Nissl, Giemsa or Luxol Fast Blue staining.
3. Study of olfaction in *Drosophila*.
4. Study of novelty, anxiety and spatial learning in mice.

**SUGGESTED READINGS**

- Neuroscience: Exploring the brain by Mark F. Baer; Barry W. Connors. 2015
- From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience by John H. Byrne. Ruth Heidelberg and M. Neal Waxham
- Neuroscience-Eds. Dale Purves et. al. (3rd Edn)-Sinauer Associates, Inc.-2004
- Principles of Neural Science-4th Edn-Eds. Kandel, Schwartz and Jessell- McGraw-Hill Companies-2000
- Nerve Cells and Animal Behaviour-2nd Edn-Peter J Simmons and David Young- CUP-2003
- Essential Psychopharmacology-Neuroscientific Basis and Practical Applications- 2<sup>nd</sup> Edn.-Stephan M. Stahl-CUP-2000
- Phantoms in the Brain - Vilayanur S. Ramachandran and Sandra Blakeslee-1998
- The Human Brain Book - Rita Carter-2009

**Course Code: ZD606T**

**DSE Course VI:**

**ANIMAL BIOTECHNOLOGY**

**THEORY**

**(Credits 4)  
(Lectures=60)**

**Unit 1. Introduction**

**8 Lectures**

Concept and scope of biotechnology

**Unit 2. Molecular Techniques in Gene manipulation**

**24 Lectures**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).

Restriction enzymes: Nomenclature, detailed study of Type II.

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

Southern blotting,

DNA sequencing: Sanger method

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

**Unit 3. Genetically Modified Organisms**

**18 Lectures**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.

Applications of transgenic plants: insect and herbicide resistant plants.

**Unit 4. Culture Techniques and Applications**

**10 Lectures**

Animal cell culture, expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

**Course Code: ZD606P**  
**ANIMAL BIOTECHNOLOGY**

**PRACTICAL**

**(Credits 2)**

1. Genomic DNA isolation from *E. coli*
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*
3. Restriction digestion of DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided..
6. To study following techniques through photographs
  - a. Southern Blotting
  - b. PCR
  - c. DNA fingerprinting
7. Project report on animal cell culture

**SUGGESTED READINGS**

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics*. V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y.,USA.
- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics*. VI Edition, Oxford University Press.

**Course Code: ZD607T**

**DSE Course - VII:**

**FISH AND FISHERIES**

**THEORY**

**(Credits 4)  
(Lectures=60)**

**UNIT 1: Introduction and Classification:**

**6 Lectures**

General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.

**UNIT 2: Morphology and Physiology:**

**18 Lectures**

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Communication in teleosts; Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminescence; Mechanoreceptors; Schooling; Parental care; Migration

**UNIT 3: Fisheries**

**12 Lectures**

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

**Unit 4: Aquaculture**

**20 Lectures**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Fungal, Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by- products

**UNIT 5: Fish in research**

**4 Lectures**

Transgenic fish, Zebrafish as a model organism in research

**Course Code: ZD607P**  
**FISH AND FISHERIES**

**PRACTICAL**

**(Credits 2)**

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Sardinella*, *Tenuulosa*, *Mugil*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
6. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*
7. Demonstration of induced breeding in Fishes (video)
8. Demonstration of parental care in fishes (video)
9. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

**SUGGESTED READINGS**

- Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
- D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
- C.B.L. Srivastava, Fish Biology, Narendra Publishing House
- J.R. Norman, A history of Fishes, Hill and Wang Publishers
- S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House



**Course Code: ZD608T**  
**DSE Course VIII:**  
**IMMUNOLOGY**

<b>THEORY</b>	<b>(Credits 4)</b>
	<b>(Lectures=60)</b>
<b>Unit 1: Overview of Immune System</b>	<b>10 Lectures</b>
Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system	
<b>Unit 2: Innate and Adaptive Immunity</b>	<b>10 Lectures</b>
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).	
<b>Unit 3: Antigens</b>	<b>8 Lectures</b>
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes	
<b>Unit 4: Immunoglobulins</b>	<b>12 Lectures</b>
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis	
<b>Unit 5: Major Histocompatibility Complex</b>	<b>7 Lectures</b>
Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation	
<b>Unit 6: Cytokines</b>	<b>4 Lectures</b>
Properties and functions of cytokines, Therapeutics Cytokines	
<b>Unit 7: Complement System</b>	<b>4 Lectures</b>
Components and pathways of complement activation.	
<b>Unit 8: Vaccines</b>	<b>5 Lectures</b>
Various types of vaccines.	

**Course Code: ZD608P**  
**IMMUNOLOGY**

**PRACTICAL**

**(Credits 2)**

- 1.\* Demonstration of lymphoid organs (by video)
  2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
  3. Preparation of stained blood film to study various types of blood cells.
  4. Ouchterlony's double immuno-diffusion method.
  5. ABO blood group determination.
  6. Demonstration of ELISA
- \* The experiments can be performed depending upon usage of animals in UG courses.

**SUGGESTED READINGS**

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lichtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

**Course Code: ZD609T****DSE Course X: PARASITOLOGY****THEORY****(CREDITS 4)  
(Lectures=60)****Unit I: Introduction to Parasitology****3 Lectures**

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

**Unit II: Parasitic Protists****15 Lectures**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*

**Unit III: Parasitic Platyhelminthes****15 Lectures**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana*

**Unit IV: Parasitic Nematodes****15 Lectures**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Study of structure, life cycle and importance of *Meloidogyne* (root knot nematode), *Pratylenchus* (lesion nematode)

**Unit IV: Parasitic Arthropoda****10 Lectures**

Biology, importance and control of ticks, mites, *Pediculus humanus* (head and body louse), *Xenopsylla cheopis* and *Cimex lectularius*

**Unit V: Parasitic Vertebrates****2 Lectures**

A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat

**Course Code: ZD609P**  
**PARASITOLOGY**

**PRACTICAL****(Credits2)**

- Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs
- Study of adult and life stages of *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana* through permanent slides/micro photographs
- Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/micro photographs
- Study of plant parasitic root knot nematode, *Meloidogyne* from the soil sample
- Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
- Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]

**Submission of a brief report on parasitic****vertebrates SUGGESTED READINGS**

- Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications and Distributors
- E.R. Noble and G.A. Noble (1982) *Parasitology: The biology of animal parasites*. V Edition, Lea & Febiger
- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease*. Taylor and Francis Group
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. *Medical Parasitology*, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
- Meyer, Olsen & Schmidt's *Essentials of Parasitology*, Murray, D. Dailey, W.C. Brown Publishers
- K. D. Chatterjee (2009). *Parasitology: Protozoology and Helminthology*. XIII Edition, CBS *Publishers* & Distributors (P) Ltd.

**Course Code: ZD610T**  
**DSE Course X:**  
**REPRODUCTIVE BIOLOGY**

**THEORY**

**(CREDITS 4)**  
**(Lectures=60)**

**Unit 1: Reproductive Endocrinology**

**15 Lectures**

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

**Unit 2: Functional anatomy of male reproduction**

**15 Lectures**

Outline and histological study of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: hormonal regulation; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

**Unit 3: Functional anatomy of female reproduction**

**20 Lectures**

Outline and histological study of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; implantation, gestation, parturition, Lactation

**Unit 4: Reproductive Health**

**10 Lectures**

Infertility in male and female: causes; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

**Course Code: ZD610P**  
**REPRODUCTIVE BIOLOGY**

**PRACTICAL**

**(CREDITS 2)**

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Surgical techniques: principles of surgery in endocrinology. Ovariectomy, hysterectomy, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Study of modern contraceptive devices

**SUGGESTED READINGS**

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

**Course Code: ZD611T**

**DSE Course XI:**

**WILD LIFE CONSERVATION AND MANAGEMENT**

**THEORY**

**(CREDITS 4)**

**(Lectures=60)**

**Unit 1: Introduction to Wild Life**

**5 Lectures**

Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

**Unit 2: Evaluation and management of wild life**

**11 Lectures**

Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

**Unit 3: Management of habitats**

**9 Lectures**

Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats

**Unit 4: Population estimation**

**12 Lectures**

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

**Unit 5: Management planning of wild life in protected areas**

**7 Lectures**

Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbation.

**Unit 7: Management of excess population**

**7 Lectures**

Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal

**Unit 8: Protected areas**

**9 Lectures**

National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

**Course Code: ZD611P**  
**WILD LIFE CONSERVATION AND MANAGEMENT**

**PRACTICALS**

**(CREDITS 2)**

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna (Museum Specimens)
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)
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for flora and fauna for population study
5. PCQ, Ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)

**SUGGESTED READINGS**

- Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.
- Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). *People and Wildlife, Conflict or Co-existence?* Cambridge University.
- Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats*, 5 th edition. The Wildlife Society, Allen Press.
- Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences
- 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.



## GENERIC ELECTIVE COURSES

### GE I:

#### ANIMAL CELL BIOTECHNOLOGY

<b>THEORY</b>	<b>(CREDITS 4)</b> <b>(Lectures=60)</b>
<b>UNIT 1: Introduction</b>	<b>5 Lectures</b>
Concept and Scope of Biotechnology	
<b>UNIT2:Techniques in Gene manipulation</b>	<b>15 Lectures</b>
Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, HAC. Shuttle and Expression Vectors.	
	<b>12 Lectures</b>
<b>UNIT 3: Animal cell Culture</b>	
Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures.	
Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting.	
<b>UNIT 4: Fermentation</b>	<b>8 Lectures</b>
Different types of Fermentation: Submerged & Solid state; batch, Fed batch &Continuous; Fixed Bed and Fluidized.	
Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.	
<b>UNIT 5: Transgenic Animal Technology</b>	
Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly.	
<b>UNIT6: Application in Health</b>	<b>8 Lectures</b>
Development of recombinant Vaccines, Hybridoma technology, Gene Therapy.	
Production of recombinant Proteins: Insulin and growth hormones.	
<b>UNIT 7: Bio safety Physical and Biological containment.</b>	<b>4 Lectures</b>

## GE I: ANIMAL CELL BIOTECHNOLOGY

### PRACTICAL

(CREDITS 2)

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from *E. coli*/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Restriction digestion of lambda ( $\lambda$ ) DNA using EcoR1 and Hind III.
6. Techniques: PCR, Southern Blot

### SUGGESTED READINGS

- Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited.
- Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press.
- P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003).
- B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
- T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
- Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).
- Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman & H.H. Zhang, 1997, CRC Press, New York
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA

**GE II:ANIMAL DIVERSITY**

<b>THEORY</b>	<b>(CREDITS 4)</b> <b>(Lectures=60)</b>
<b>Unit 1. Protista</b> General characters of Protozoa; Life cycle of Plasmodium	<b>4 Lectures</b>
<b>Unit 2. Porifera</b> General characters and canal system in Porifera	<b>3 Lectures</b>
<b>Unit 3. Radiata</b> General characters of Cnidarians and polymorphism	<b>3 Lectures</b>
<b>Unit 4. Aceolomates</b> General characters of Helminthes; Life cycle of <i>Taenia solium</i>	<b>3 Lectures</b>
<b>Unit 5. Pseudocoelomates</b> General characters of Nemethehelminthes; Parasitic adaptations	<b>3 Lectures</b>
<b>Unit 6. Coelomate Protostomes</b> General characters of Annelida ; Metamerism.	<b>3 Lectures</b>
<b>Unit 7. Arthropoda</b> General characters. Social life in insects.	<b>4 Lectures</b>
<b>Unit 8. Mollusca</b> General characters of mollusca; Pearl Formation	<b>3 Lectures</b>
<b>Unit 9. Coelomate Deuterostomes</b> General characters of Echinodermata, Water Vascular system in Starfish.	<b>3 Lectures</b>
<b>Unit 10. Protochordata</b> Salient features	<b>2 Lectures</b>
<b>Unit 11. Pisces</b> Osmoregulation, Migration of Fishes	<b>4 Lectures</b>
<b>Unit 12. Amphibia</b> General characters, Adaptations for terrestrial life, Parental care in Amphibia.	<b>4 Lectures</b>
<b>Unit 13.</b> Amniotes; Origin of reptiles. Terrestrial adaptations in reptiles.	<b>5 Lectures</b>
<b>Unit 14. Aves:</b> The origin of birds; Flight adaptations	<b>5 Lectures</b>
<b>Unit 15. Mammalia</b> Early evolution of mammals; Primates; Dentition in mammals.	<b>6 Lectures</b>

**GE II: ANIMAL DIVERSITY****PRACTICAL****(CREDITS 2)**

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, Dentalium, Octopus, Asterias, and Antedon.*

**Chordates:** *Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.*

2. Study of following Permanent Slides:

Cross section of Sycon, Sea anemone and *Ascaris*(male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva.

3. Temporary mounts of

- Septal & pharyngeal nephridia of earthworm.
- Unstained mounts of Placoid, cycloid and ctenoid scales.

4. Dissections of

- Digestive and nervous system of Cockroach.
- Urinogenital system of fish

**SUGGESTED BOOKS**

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

**GE III: AQUATIC  
BIOLOGY**

**THEORY**

**(Credits 4)**

**(Lectures=60)**

**UNIT 1: Aquatic Biomes**

**10 Lectures**

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

**UNIT 2: Freshwater Biology**

**15 Lectures**

**Lakes:** Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

**River:** Ecology of river, riverine biota (Fish, prawn, molluscs and mammals)

**Streams:** Different stages of stream

development, Physico-chemical environment,

Adaptation of hill-stream fishes, coldwater fishes

**UNIT 3: Marine Biology**

**10 Lectures**

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds, major fishes and invertebrate groups

**UNIT 4: Wetland Biology**

**15 Lectures**

Definition & types of wetlands, major wetlands in Assam, wetland biota: Major invertebrates (insects & prawns) and vertebrates (fish, reptiles and avian fauna)

**UNIT 5: Management of Aquatic Resources**

**10 Lectures**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

### **GE III: AQUATIC BIOLOGY**

#### **PRACTICAL**

**(Credits 2)**

1. Determine the area of a freshwater body using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bio- reserve/Fisheries Institutes/Wetlands

#### **SUGGESTED READINGS**

- Anathakrishnan : Bioresources Ecology 3<sup>rd</sup> Edition
- Goldman : Limnology, 2<sup>nd</sup> Edition
- Odum and Barrett : Fundamentals of Ecology, 5<sup>th</sup> Edition
- Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1<sup>st</sup> Edition
- Wetzel : Limnology, 3<sup>rd</sup> edition
- Trivedi and Goyal : Chemical and biological methods for water pollution studies
- Welch : Limnology Vols. I-II

## GE IV: ENVIRONMENT AND PUBLIC HEALTH

### THEORY

(Credits 4)  
(Lectures=60)

#### UNIT I: Introduction

12 Lectures

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

#### UNIT II Climate Change

10 Lectures

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

#### Unit III Pollution

10 Lectures

Air, water, noise pollution sources and effects, Pollution control

#### Unit IV Waste Management Technologies

18 Lectures

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.

#### Unit 5 Diseases

10 Lectures

Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid

## GE IV: ENVIRONMENT AND PUBLIC HEALTH

### PRACTICAL

(Credits 2)

1. To determine pH, Cl, SO<sub>4</sub>, NO<sub>3</sub> in soil and water samples from different locations.

### SUGGESTED BOOKS

- Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
- Kolluru Rao, Bartell Steven, Pitblado R and Stricoff –Risk Assessment and Management Handbook, McGraw Hill Inc., New York, 1996.
- Kofi Asante Duah –Risk Assessment in Environmental management, John Wiley and sons, Singapore, 1998.
- Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. University Press, New York, 2003.
- Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.



**GE V:**

**EXPLORING THE BRAIN: STRUCTURE AND FUNCTION**

**THEORY**

**(Credits 4)  
(Lectures=60)**

**Unit 1: Introduction:**

**5 Lectures**

Early and Nineteenth century views of the Brain; Neuroscience today; Evolution of brain in vertebrates

**Unit 2: Neurons and Glia:**

**4 Lectures**

Neurons – Soma, Axon, Dendrite; Classification of Neurons; Glia – Astrocytes, Myelinating Glia, Non-neuronal cells

**Unit 3: Evolution and Adaptation of Brain:**

**8 Lectures**

Brain evolution and behavioral adaptation; Theories of brain evolution – involving addition of structure or areas, involving new formation and reorganization of circuits.

**Unit 4: Organization of the Brain:**

**10 Lectures**

Anatomical references, Cerebrum, cerebellum, brain stem, spinal cord; Cranial nerves, Meninges, ventricular system; CT and MRI imaging of the brain

**Unit 5: Understanding Brain Structure through Development:**

**10 Lectures**

Formation of neural tube, Primary brain vesicles; Differentiation of forebrain, midbrain and hindbrain. Cerebral cortex – neocortical evolution and structure-function relationship

**Unit 6: Chemical Control of Brain and Behaviour:**

**8 Lectures**

Structure and connection of the secretory hypothalamus; Diffuse modulatory systems of the brain – noradrenergic, serotonergic, dopaminergic and cholinergic system; Drugs and diffuse modulatory systems.

**Unit 7: Rhythms of the Brain:**

**7 Lectures**

Electroencephalogram; Sleep – why do we sleep, Non-REM and REM sleep, neural mechanisms of sleep; Circadian rhythms.

**Unit 8: Mental illness and the Brain:**

**8 Lectures**

Psychosocial and biological approaches to mental illness; Anxiety disorders; Mood disorders; Schizophrenia.

**GE V: EXPLORING THE BRAIN: STRUCTURE AND FUNCTION**

**PRACTICAL**

**(CREDITS 2)**

1. Observation and quantitation of *Drosophila* photoreceptor neurons in healthy and diseased condition.

**SUGGESTED READINGS**

1. Neuroscience: Exploring the Brain by Mark F. Bear, Barry W. Connors and Michael A. Paradiso.
2. Comparative vertebrate Neuroanatomy by Ann B. Butler and William Hoods.

Project work/ Home assignment

## GE VI: FOOD, NUTRITION AND HEALTH

### THEORY

(Credits 4 )  
(Lectures=60)

#### Unit 1: Basic concept of food and nutrition

10 Lectures

Food Components and food-nutrients

Concept of a balanced diet, nutrient needs and dietary pattern for various groups-adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

#### Unit 2: Nutritional Biochemistry:

20 Lectures

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

#### Unit 3: Health

15 Lectures

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 Common ailments- cold, cough, and fevers, their causes and treatment

#### Unit 4: Food hygiene:

15 Lectures

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:** taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention

Brief account of food spoilage: Causes of food spoilage and their preventive measures

## GE VI: FOOD, NUTRITION AND HEALTH

### PRACTICAL

(Credits 2)

1. Estimation of Lactose in milk
2. Ascorbic acid estimation in food by titrimetry
3. Estimation of Calcium in foods by titrimetry
4. 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.
5. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups.

OR

Identify nutrient rich sources of foods (**fruits and vegetables**), their seasonal availability and price

OR

Study of nutrition labeling on selected foods

### SUGGESTED BOOKS

- Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
- Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
- Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
- Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
- Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
- Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.
- Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing

## GE VII: HUMAN PHYSIOLOGY

### THEORY

(CREDITS 4)

(Lectures=60)

#### **Unit 1: Digestion and Absorption of Food**

**12 Lectures**

Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (*in brief*)

#### **Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)**

**10 Lectures**

Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction

#### **Unit 3: Respiratory Physiology**

**6 Lectures**

Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

#### **Unit 4: Renal Physiology**

**8 Lectures**

Functional anatomy of kidney, Mechanism and regulation of urine formation,

#### **Unit 5: Cardiovascular Physiology**

**10 Lectures**

Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG

#### **Unit 6: Endocrine and Reproductive Physiology**

**14 Lectures**

Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle

## GE VII: HUMAN PHYSIOLOGY

### PRACTICAL

(CREDITS 2)

1. Preparation of temporary mount of Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary and nerve cells

### SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley and Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008). *Vander's Human Physiology*, XI Edition, McGraw Hill.
- Guyton, A.C. and Hall, J.E. (2011). *Textbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
- Marieb, E. (1998). *Human Anatomy and Physiology*, IV Edition, Addison-Wesley.
- Kesar, S. and Vashisht, N. (2007). *Experimental Physiology*, Heritage Publishers.
- Prakash, G. (2012). *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Company Ltd.

**GE VIII:  
INSECT VECTORS AND DISEASES**

<b>THEORY</b>	<b>(Credits 4) (Lectures=60)</b>
<b>Unit I: Introduction to Insects</b>	<b>6 Lectures</b>
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits	
<b>Unit II: Concept of Vectors</b>	<b>6 Lectures</b>
Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity	
<b>Unit III: Insects as Vectors</b>	<b>8 Lectures</b>
Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera	
<b>Unit IV: Dipteran as Disease Vectors</b>	<b>24 Lectures</b>
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, 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	
<b>Unit IV: Siphonaptera as Disease Vectors</b>	<b>6 Lectures</b>
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas	
<b>Unit V: Siphunculata as Disease Vectors</b>	<b>4 Lectures</b>
Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever Control of human louse	
<b>Unit VI: Hemiptera as Disease Vectors</b>	<b>6 Lectures</b>
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	

## GE VIII : INSECT VECTORS AND DISEASES

### PRACTICAL

CREDITS -2

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanus capitis*, *Pediculus humanus corporis*, *Phthirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica*, through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors

**Submission of a project report on any one of the insect vectors and disease transmitted**

### SUGGESTED READINGS

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



## SKILL ENHANCEMENT COURSES

### SEC I: APICULTURE

#### THEORY

(CREDITS 2)  
(Lectures=30)

#### Unit 1: Biology of Bees (4)

History, Classification and Biology of Honey, Bee species, Bees Social Organization of Bee Colony, Bee plants

#### Unit 2: Rearing of Bees

10 Lectures

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth  
Bee Pasturage  
Selection of Bee Species for Apiculture  
Bee Keeping Equipment  
Methods of Extraction of Honey (Indigenous and Modern)

#### Unit 3: Diseases and Enemies

5 Lectures

Bee Diseases and Enemies  
Control and Preventive measures

#### Unit 4: Bee Economy

2 Lectures

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

#### Unit 5: Entrepreneurship in Apiculture

4 Lectures

Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

#### SUGGESTED READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Bisht D.S., *Apiculture*, ICAR Publication.
- Singh S., *Beekeeping in India*, Indian council of Agricultural Research, NewDelhi.

## SEC II: MEDICAL DIAGNOSTICS

### THEORY

(Credits 2)  
(Lectures=30)

- Unit 1: Introduction to Medical Diagnostics and its Importance** 2 Lectures
- Unit 2: Diagnostics Methods Used for Analysis of Blood** 10 Lectures  
Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)
- Unit 3: Diagnostic Methods Used for Urine Analysis** 6 Lectures  
Urine Analysis: Physical characteristics; Abnormal constituents
- Unit 4: Non-infectious Diseases** 6 Lectures  
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
- Unit 5: Infectious Diseases** 3 Lectures  
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis
- Unit 6: Tumours** 3 Lectures  
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, MRI and CT Scan (using photographs).

### SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

### SEC III: SERICULTURE

#### THEORY

(CREDITS 2)  
(Lectures=30)

#### Unit 1: Introduction

3 Lectures

Sericulture: Definition, history and present status; Silk route

Types of silkworms, Distribution and Races

Exotic and indigenous races, Hybrids

Mulberry and non-mulberry Sericulture

#### Unit 2: Biology of Silkworm

3 Lectures

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

Sex linked traits

#### Unit 3: Rearing of Silkworms

15 Lectures

Mulberry silkworm rearing : Selection of mulberry variety and establishment of mulberry garden

Rearing house and rearing appliances

Disinfectants: Formalin, bleaching powder, RKO

Silkworm rearing technology: Early age and Late age rearing

Types of mountages

Spinning, harvesting and storage of cocoons

Non mulberry silkworm rearing: Host plants of non mulberry silkworm,

maintenance of host plants of *Anthereae assama*, rearing technology of *Anthereae spp* and *Samia cynthia ricini*

#### Unit 4: Pests and Diseases

4 Lectures

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates

Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial

Control and prevention of pests and diseases

#### Unit 5: Entrepreneurship in Sericulture

5 Lectures

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.

#### SUGGESTED READINGS

- Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

**SEC IV: AQUARIUM FISH KEEPING**

**THEORY**

**(CREDITS 2)**

**(Lectures =30)**

**Unit1: Introduction to Aquarium Fish Keeping**

**5 Lectures**

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

**Unit 2: Biology of Aquarium Fishes**

**8 Lectures**

Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish, Botia, Gourami

**Unit 3: Food and feeding of Aquarium fishes**

**5 Lectures**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

**Unit 4: Fish Transportation**

**5 Lectures**

Live fish transport - Fish handling, packing and forwarding techniques.

**Unit 5: Maintenance of Aquarium**

**7 Lectures**

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

**SEC V:**

**RESEARCH METHODOLOGY**

**THEORY**

**(CREDITS 2)**

**(Lectures=30)**

**Unit 1: Foundations of Research**

**5 Lectures**

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

**Unit 2: Research Design**

**8 Lectures**

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

**Unit 3: Data Collection, Analysis and Report Writing**

**12 Lectures**

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

**Unit 4: Ethical Issues**

**5 Lectures**

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

**SUGGESTED READINGS**

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