

Vidyasagar University

Curriculum for B.Sc. Honours in Zoology

[Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	C1T: Non- Chordates-I	Core Course-1		4	0	0	6	75
	C1P: Non- Chordates-I (Practical)	Core Course1 [Practical]		0	0	4		
C2	C2T: Ecology	Core Course-2		4	0	0	6	75
	C2P:Ecology (Practical)	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	50
				Total Credits =20				

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language.

Interdisciplinary/Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline (GE-1 Preferably Chemistry/Physiology):Chemistry/Botany/Physiology/ComputerSc./Microbiology/Bio Technology/ Geology /Nutrition /Aquaculture Management.

Semester -1

Core Courses-1

CC-1: Non-Chordates I

Credits 06

C1T1 –Non-Chordates I

Credits 04

Non-Chordates I		
	4 Credits	Class
Unit 1: Basics of Animal Classification		4
Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Six kingdom concept of classification (Card woese)		
Unit 2: Protista and Metazoa		15
Protozoa General characteristics and Classification up to phylum (according to Levine et. al., 1981) Locomotion in <i>Euglena</i> , <i>Paramoecium</i> and <i>Amoeba</i> ; Conjugation in <i>Paramoecium</i> . Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i> Metazoa Evolution of symmetry and segmentation of Metazoa		

Unit 3: Porifera	6
General characteristics and Classification up to classes; Canal system and spicules in sponges	
Unit 4: Cnidaria	10
General characteristics and Classification up to classes Metagenesis in <i>Obelia</i> & <i>Aurelia</i> Metagenesis in <i>Obelia</i> Polymorphism in Cnidaria Corals and coral reef diversity, function & conservation	
Unit 5: Ctenophora	2
General characteristics	
Unit 6: Platyhelminthes	6
General characteristics and Classification up to classes Life cycle and pathogenicity and control measures of <i>Fasciola hepatica</i> and <i>Taenia solium</i>	
Unit 7: Nematoda	7
General characteristics and Classification up to classes Life cycle, and pathogenicity and control measures of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i> Parasitic adaptations in helminthes	
Reference Books	
► Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.	

► Invertebrates by Brusca & Brusca. Second edition, 2002.

Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th Edition.

C1 P1 –Non-Chordates I Lab

Credits 02

List of Practical

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*
2. Identification of *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium vivax* and *Plasmodium falciparum* (from the prepared slides)
3. Identification of *Sycon*, Neptune's Cup, *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
4. Identification and significance of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides*
5. Staining/mounting of any protozoa/helminth from gut of cockroach

Core -2

CC-2: Ecology

Credits 06

C2 T2 –Ecology

Credits 04

Ecology		
	4 Credits	Class
Unit 1: Introduction to Ecology		4
<p>History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.</p>		
Unit 2: Population		20
<p>Unitary and Modular populations</p> <p>Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion.</p> <p>Geometric, exponential and logistic growth, equation and patterns, r and K strategies</p> <p>Population regulation - density-dependent and independent factors</p> <p>Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.</p>		
Unit 3: Community		11
<p>Community characteristics: species diversity, abundance, , dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession with one example</p>		
Unit 4: Ecosystem		10
<p>Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains,</p>		

<p>Linear</p> <p>and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and</p> <p>Ecological efficiencies</p> <p>Nutrient and biogeochemical cycle with an example of Nitrogen cycle</p> <p>Human modified ecosystem</p>	
Unit 5: Applied Ecology	5
<p>Wildlife Conservation (in-situ and ex-situ conservation).</p> <p>Management strategies for tiger conservation; Wild life protection act (1972)</p>	

Reference Books

- ▶ 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
- ▶ Ecology: Theories & Application (2001). 4th Edition by Peter Stilling.
- ▶ Ecology by Cain, Bowman & Hacker. 3rd edition. Sinauer associates

List of Practical

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), Chemical Oxygen Demand and free CO₂
4. **Report on a visit to National Park/Biodiversity Park/Wild life sanctuary**

Note: In field report costal area to be included.

Generic Elective Syllabus

GE-1 [Interdisciplinary for other department]

GE-1 -Animal Cell Biotechnology

Credits 06

GE-1 T1 -Animal Cell Biotechnology

Credits 04

Animal Cell Biotechnology

4 Credits Class

Unit 1: Introduction

2

Concept and Scope of Biotechnology

Unit 2: Techniques in Gene manipulation

15

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, and HAC. Shuttle and

Expression Vectors.

Construction of Genomic libraries and cDNA libraries

Transformation techniques: microbial, plants and animals: Cloning in mammalian cells, Integration

of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.

Unit 3: Animal cell Culture

9

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 and DNA microarrays.

Unit 4: Fermentation

8

Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred

tank, Air Lift, Fixed Bed and Fluidized.

Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and

lyophilization.

Unit 5: Transgenic Animal Technology

6

Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection

method, Dolly and Polly.

Unit 6: Application in Health

6

Development of recombinant Vaccines, Hybridoma technology, Gene Therapy. Production of

recombinant Proteins: Insulin and growth hormones.

Unit 7: Bio safety Physical and Biological containment

4

Reference Books

- ▶ 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

List of Practical

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 (p UC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.
6. Preparation of competent cells and Transformation of E. coli with plasmid DNA using CaCl₂, Selection of transformants on X-gal and IPTG (Optional).
7. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays

Vidyasagar University
Curriculum for B.Sc. Honours in Zoology [Choice Based Credit System]

Semester-II

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C3	C3T: Non- Chordates-II	Core Course-3		4	0	0	6	75
	C3P: Non- Chordates-II (Practical)	Core Course-3 [Practical]		0	0	4		
C4	C4T: Cell Biology	Core Course-4		4	0	0	6	75
	C4P: Cell Biology (Practical)	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AECC-2	Environmental Studies	AECC					4	100
				Total Credits =22				

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.

Interdisciplinary/Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline
Chemistry/Botany/Physiology/Computer Sc./Microbiology/Bio Technology/ Geology /Nutrition /Aquaculture Management.

Semester –II

Core Courses Core-3

CC-3 :Non-Chordates II

Credits 06

C3 T - Non-Chordates II

Credits 04

C3 T - Non-Chordates II

4 Credits

Class

Unit 1: Introduction

2

Evolution of coelom and metamerism

Unit 2: Annelida

10

General characteristics and Classification up to classes

Excretion in Annelida through nephridia.

Metamerism in Annelida.

Unit 3:Arthropoda

16

General characteristics and Classification up to classes Vision in Insecta only.

Respiration in Arthropoda (Gills in prawn and trachea in cockroach)

Metamorphosis in Lepidopteran Insects.

Social life in termite

Unit 4: Onychophora

2

General characteristics and Evolutionary significance

Unit 5: Mollusca

10

General characteristics and Classification up to classes

Nervous system and torsion in Gastropoda

Feeding and respiration in *Pila* sp

Unit 6: Echinodermata

8

General characteristics and Classification up to classes
Water-vascular system in Asteroidea

Larval forms in Echinodermata

Affinities with Chordates

Unit 7: Hemichordata

2

General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates

Reference Books

- ▶ Rupert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition
- ▶ The Invertebrates: A New Synthesis, III Edition, Blackwell Science

Note: Classification to be followed from Rupert and Barnes, 1994, 6th Edition.

C3 P – Non-Chordates II

Credits 02

List of Practical

1. Study of following specimens:
 - a. Annelids - *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria*
 - b. Arthropods - *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta*, termites and honey bees *Onychophora* - *Peripatus*
 - c. Molluscs - *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Pinctada*, *Sepia*, *Octopus*, *Nautilus*
 - d. Echinodermates - *Pentaceros/Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Cucumaria* and
 - e. *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)

Core-4

CC-4 : Cell Biology

Credits 06

C4 T: Cell Biology

Credits 04

C4 T - Cell Biology

4 Credits Class

Unit 1: Overview of Cells

2

Basic structure of Prokaryotic and Eukaryotic cells, Viruses, Viroid, Prion and Mycoplasma

Unit 2: Plasma Membrane

6

Ultra structure and composition of Plasma membrane: Fluid mosaic model

Transport across membrane: Active and Passive transport, Facilitated transport

Cell junctions: Tight junctions, Gap junctions, Desmosomes

Unit 3: Cytoplasmic organelles I

5

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Protein sorting and mechanisms of vesicular transport

Unit 4: Cytoplasmic organelles II

6

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis

Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis

Peroxisomes: Structure and Functions

Centrosome: Structure and Functions

Unit 5: Cytoskeleton

5

Type, structure and functions of cytoskeleton

Accessory proteins of microfilament & microtubule

A brief idea about molecular motors

Unit 6: Nucleus

8

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus

Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)

Unit 7: Cell Division

10

Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC. Mitosis and Meiosis: Basic process and their significance

Unit 8: Cell Signaling

8

Cell signalling transduction pathways; Types of signaling molecules and receptors
GPCR and Role of second messenger (cAMP)
Extracellular matrix-Cell interactions
Apoptosis and Necrosis

Reference Books

- ▶ Lewin's Cells – 3rd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers
- ▶ Biology of Cancer by Robert. A. Weinberg. 2nd edition.
- ▶ 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.
- ▶ 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.

C4P–Cell Biology (Lab)

Credits 02

Cell Biology

List of Practical

1. Preparation of temporary stained squash of onion root tip 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:
 - a. DNA by Feulgen reaction
 - b. Cell viability study by Trypan Blue staining
 - c. Mitochondria identification through vital staining

Generic Elective Syllabus
GE-2 [Interdisciplinary for other department]

GE-2 :Animal Diversity **Credits 06**

GE2 T:Animal Diversity **Credits 04**

GE2 T-Animal Diversity

	4 Credits	Class
Unit 1: Protista		3
Protozoa : General characters of Protozoa; Life cycle of <i>Plasmodium</i>		
Unit 2: Porifera		3
General characters and canal system in Porifera		
Unit 3: Radiata		3
General characters of Cnidarians and polymorphism		
Unit 4: Aceolomates		2
General characters of Helminthes		
Unit 5: Pseudocoelomates		3
General characters of Nematoda Parasitic adaptations		
Unit 6: Annelida		3
General characters of Annelida Metamerism		
Unit 7: Arthropoda		4
General characters. Social life in insects.		
Unit 8: Mollusca		4
General characters of mollusk. Pearl Formation		
Unit 9: Echinodermata		4
General characters of Echinodermata. Water Vascular system in Starfish.		

Unit 10: Protochordata 2

Salient features

Unit 11: Pisces 3

General Characters.
Osmoregulation, Migration of Fish

Unit 12: Amphibia 4

General characters, Adaptations for terrestrial life, Parental care

Unit 13: Reptilia 4

General Characters.
Amniotes; Origin of reptiles. Terrestrial adaptations in reptiles.

Unit 14: Aves 4

General Characters.
The origin of birds; Flight adaptations

Unit 15: Mammalia 4

General Characters.
Early evolution of mammals; Primates; Dentition in mammals.

Reference 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.

List of Practical

1. Study of following specimens:
 - a. 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*.
 - b. 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:
 - a. Septal & pharyngeal nephridia of earthworm.
 - b. Unstained mounts of Placoid, cycloid and ctenoid scales.
4. Dissections of:
 - a. Digestive and nervous system of Cockroach
 - b. Urinogenital system of Rat

Vidyasagar University

Curriculum for B.Sc (Honours) in Zoology [Choice Based Credit System]

Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		C5T:Chordates	Core Course - 5	4	0	0	6	75
		C5P:Chordates Lab		0	0	4		
CC-6		C6T:Animal Physiology: Controlling & Coordinating Systems	Core Course - 6	4	0	0	6	75
		C6P:Animal Physiology: Controlling & Coordinating Systems Lab		0	0	4		
CC-7		C7T:Fundamentals of Biochemistry	Core Course - 7	4	0	0	6	75
		C7P:Fundamentals of Biochemistry Lab		0	0	4		
GE-3	TBD		Generic Elective -3				4/5	75
							2/1	
SEC-1		SEC-1:Apiculture Or SEC-1:Aquarium Fish Keeping	Skill Enhancement Course-1	1	1	0	2	50
Semester Total							26	350

L=Lecture, T= Tutorial, P=Practical, CC = Core Course, GE= Generic Elective, SEC = Skill Enhancement Course, TBD = to be decided

Generic Elective (GE) (Interdisciplinary) from other Department [Four papers are to be taken and each paper will be of 6 credits]:

Papers are to be taken from any of the following discipline:

Chemistry /Botany/Physiology/Computer Sc./Microbiology /Bio Technology/ Geology /Nutrition /Aquaculture Management.

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Semester- III
Core Course (CC)

CC-5: Chordates

Credits 06

C5T: Chordates

Credits 04

Unit 1: Introduction to Chordates

General characteristics and outline classification of Phylum Chordata

Unit 2: Protochordata

General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in *Ascidia*. Chordate Features and Feeding in *Branchiostoma*

Unit 3: Origin of Chordata

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

Unit 4: Agnatha

General characteristics and classification of cyclostomes up to order

Unit 5: Pisces

General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses

Accessory respiratory organ, migration and parental care in fishes

Swim bladder in fishes. Classification up to Sub-Classes

Unit 6: Amphibia

General characteristics and classification up to living Orders.

Metamorphosis and parental care in Amphibia

Unit 7: Reptilia

General characteristics and classification up to living Orders.

Poison apparatus and Biting mechanism in Snake

Unit 8: Aves

General characteristics and classification up to Sub-Classes

Exoskeleton and migration in Birds

Principles and aerodynamics of flight

Unit 9: Mammals

General characters and classification up to living orders

Affinities of Prototheria

Exoskeleton derivatives of mammals

Adaptive radiation in mammals with reference to locomotory appendages

Echolocation in Micro chiropterans and Cetaceans

Unit 10: Zoogeography

Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of birds and mammals in different realms

Suggested Readings :

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
5. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
6. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
7. Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
8. Nelson, J.S., (2006) : Fishes of the World, 4th Edn., Wiley.
9. Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
10. Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
11. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
12. Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Duellman and Trueb (1986).

CP5: Chordates Lab

Credits 02

List of Practical

1. Protochordata
Balanoglossus, Herdmania, Branchiostoma
2. Agnatha
Petromyzon, Myxine
3. Fishes
Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeineis, Anguilla, Hippocampus, Tetradon/ Diodon, Anabas, Flat fish
4. Amphibia
Necturus, Bufo, Hyla, Alytes, Axolotl, Tylototriton
5. Reptilia
Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus. Key for Identification of poisonous and non-poisonous snakes
6. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
7. Pecten from Fowl head
8. Dissection of brain and pituitary of Tilapia

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

CC-6: Animal Physiology: Controlling & Coordinating Systems Credits 06

C6T: Animal Physiology: Controlling & Coordinating Systems Credits 04

Unit 1: Tissues

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue and, fixation and staining of tissues.

Unit 2: Bone and Cartilage

Structure and types of bones and cartilages, Ossification

Unit 3: Nervous System

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

Unit 4: Muscular system

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre

Unit 5: Reproductive System

Histology of testis and ovary

Physiology of Reproduction

Unit 6: Endocrine System

Histology and function of pituitary, thyroid, pancreas and adrenal

Classification of hormones; Mechanism 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

Suggested Readings :

1. Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
2. Eckert Animal Physiology by David Randall and Warren Burggren. 4th edition. W. H. Freeman.

C6P: Animal Physiology: Controlling & Coordinating Systems Lab Credits 02

List of Practical

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

CC-7: Fundamentals of Biochemistry

Credits 06

C7T: Fundamentals of Biochemistry

Credits 04

Unit 1: Carbohydrates

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosachharides

Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis

Unit 2: Lipids

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

Lipid metabolism: β -oxidation of fatty acids; Fatty acid biosynthesis

Unit 3: Proteins

Amino acids

Structure, Classification, General and Electro chemical properties of α -amino acids; Physiological importance of essential and non-essential amino acids

Proteins

Bonds stabilizing protein structure; Levels of organization

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

Unit 4: Nucleic Acids

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids

Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA

Basic concept of nucleotide metabolism

Unit 5: Enzymes

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot;

Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)

Unit 5: Oxidative Phosphorylation

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

C7P: Fundamentals of Biochemistry Lab

Credits 02

List of Practical

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Quantitative estimation of Lowry Methods.
4. Demonstration of proteins separation by SDS-PAGE.
5. To study the enzymatic activity of Trypsin and Lipase.
6. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

Suggested Readings:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A.(2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. 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.

Skill Enhancement Course (SEC)

SEC1: Apiculture

Credits 02

SEC1T: Apiculture

Unit 1: Biology of Bees

History, Classification and Biology of Honey Bees

Social Organization of Bee Colony

Unit 2: Rearing of Bees

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

Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy

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

Unit 5: Entrepreneurship in Apiculture

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

Suggested Readings :

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

Or

SEC1: Aquarium Fish Keeping

Credits 02

SEC1T: Aquarium Fish Keeping

Aquarium Fish Keeping

Unit 1: Introduction to Aquarium Fish Keeping

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

Unit 2: Biology of Aquarium Fishes

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

Unit 3: Food and feeding of Aquarium fishes

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

Unit 4: Fish Transportation

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

Unit 5: Maintenance of Aquarium

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

Generic Elective

GE-3 [Interdisciplinary for other department]

GE-3: Aquatic Biology

Credits 06

GE3T: Aquatic Biology

Credits 04

Unit 1: Aquatic Biomes

Brief introduction to 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

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).

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill- stream fishes.

Unit 3: Marine Biology

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

Unit 4: Management of Aquatic Resources

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

GE3 P: Aquatic Biology Lab

Credits 02

List of Practical

1. Determine the area of a lake 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, and 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 Institute.

Suggested Readings :

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

Vidyasagar University

Curriculum for B.Sc (Honours) in Zoology [Choice Based Credit System]

Semester-IV

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-8		C8T: Comparative Anatomy of Vertebrates	Core Course - 8	4	0	0	6	75
		C8P: Practical		0	0	4		
CC-9		C9T: Animal Physiology: Life Sustaining Systems	Core Course - 9	4	0	0	6	75
		C9P: Practical		0	0	4		
CC-10		C10T: Immunology	Core Course - 10	4	0	0	6	75
		C10P: Practical		0	0	4		
GE-4	TBD		Generic Elective -4				4/5	75
							2/1	
SEC-2		SEC2: Medical Diagnostic Techniques Or Sericulture	Skill Enhancement Course-2	1	1	0	2	50
Semester Total							26	350

L=Lecture, T= Tutorial, P=Practical, CC = Core Course, GE= Generic Elective, SEC = Skill Enhancement Course, TBD = to be decided

Generic Elective (GE) (Interdisciplinary) from other Department [Four papers are to be taken and each paper will be of 6 credits]: Chemistry/Botany/Physiology/Computer Sc./Microbiology/Bio Technology/ Geology /Nutrition /Aquaculture Management.

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Semester-IV
Core Course (CC)

CC-8: Comparative Anatomy of Vertebrates **Credits 06**

C8T: Comparative Anatomy of Vertebrates **Credits 04**

Course Contents:

Unit 1: Integumentary System

Structure, function and derivatives of integument in amphibian, birds and mammals

Unit 2: Skeletal System

Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.

Unit 3: Digestive System

Comparative anatomy of stomach; dentition in mammals

Unit 4: Respiratory System

Respiratory organs in fish, amphibian, birds and mammals

Unit 5: Circulatory System

General plan of circulation, Comparative account of heart and aortic arches

Unit 6: Urinogenital System

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

Unit 7: Nervous System

Comparative account of brain, Cranial nerves in mammals

Unit 8: Sense Organs

Classification of receptors, Brief account of olfactory and auditory receptors in vertebrate

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
Saxena, R.K. & Saxena, S.C. (2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

List of Practical

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.
2. Study of disarticulated skeleton of Toad, Pigeon and Guinea pig.
3. Demonstration of Carapace and plastron of turtle.
4. Identification of mammalian skulls: One herbivorous (Guinea pig) and one carnivorous (Dog) animal.
5. Dissection of Tilapia: Circulatory system, Brain, pituitary, urinogenital system.

CC-9: Animal Physiology: Life Sustaining Systems**Credits 06****C9T: Animal Physiology: Life Sustaining Systems****Credits 04****Course Contents:****Unit 1: Physiology of Digestion**

Structural organisation and functions of Gastrointestinal tract and Associated glands; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids, Proteins and Nucleic Acids; Digestive enzymes

Unit 2: Physiology of Respiration

Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning

Unit 3: Physiology of Circulation

Components of Blood and their functions; Structure and functions of haemoglobin Haemostasis; Blood clotting system, Fibrinolytic system Haemopoiesis; Basic steps and its regulation Blood groups; ABO and Rh factor

Unit 4: Physiology of Heart

Structure of mammalian heart, Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses Cardiac Cycle and cardiac output Blood pressure and its regulation

Unit 5: Thermoregulation & Osmoregulation

Physiological classification based on thermal biology.

Thermal biology of endotherms

Osmoregulation in aquatic vertebrates

Extrarenal osmoregulatory organs in vertebrates

Unit 6: Renal Physiology

Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance

Suggested Readings:

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt
- Asia PTE Ltd. W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
- Eckert Animal Physiology: Mechanisms and adaptations Randall, Burggren and French Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- 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

C9P: Animal Physiology: Life Sustaining Systems Lab

Credits 02

List of Practical

1. Determination of ABO Blood group
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 blood pressure using a sphygmomanometer

CC-10: Immunology

Credits 06

C10T: Immunology

Credits 04

Course Contents:

Unit 1: Overview of Immune System

Basic concepts of health and diseases, Historical perspective of Immunology, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).

Unit 3: Antigens

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

Unit 4: Immunoglobulins

Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production

Unit 5: Major Histocompatibility Complex

Structure and functions of MHC molecules.

Structure of T cell Receptor and its signalling, T cell development & selection

Unit 6: Cytokines

Types, properties and functions of cytokines.

Unit 7: Complement System

Components and pathways of complement activation.

Unit 8: Hypersensitivity

Gell and Coombs' classification and brief description of various types of hypersensitivities.

Unit 9: Immunology of diseases

Malaria, Filariasis, Dengue and Tuberculosis

Unit 10: Vaccines

Various types of vaccines. Active & passive immunization (Artificial and natural).

Suggested Readings:

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

C10P: Immunology Lab

Credits 02

List of Practical

1. Demonstration of lymphoid organs.
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. ABO blood group determination.
5. Demonstration of ELISA

Skill Enhancement Courses (SEC)

SEC-2: Medical Diagnostic Techniques

Credits 02

SEC2T: Medical Diagnostic Techniques

Course Contents:

Unit 1: Introduction to Medical Diagnostics and its Importance

Unit 2: Diagnostics Methods Used for Analysis of Blood

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

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4: Non-infectious Diseases

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

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)

Unit 6: Clinical Biochemistry

LFT, Lipid profiling

Unit 7: Clinical Microbiology

Antibiotic Sensitivity Test

Unit 8: Tumours

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

Unit 9: Visit to Pathological Laboratory and Submission of Project

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.

Or

SEC-2: Sericulture

Credits 02

SEC2T: Sericulture

Course Contents:

Unit 1: Introduction

Sericulture: Definition, history and present status; Silk route

Types of silkworms, Distribution and Races

Exotic and indigenous races

Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

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

Unit 4: Pests and Diseases

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

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:

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.

- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004,
- Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- J. Balfour, M. Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
http://en.wikipedia.org/wiki/Renewable_energy

Generic Elective Syllabus
GE-4 [Interdisciplinary for other department]

GE-4: Insect Vectors and Diseases **Credits 06**

GE4T: Insect Vectors and Diseases **Credits 04**

Course Contents:

Unit 1: Introduction to Insects

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth Parts

Unit 2: Concept of Vectors

Brief introduction to Vectors (mechanical and biological vectors),Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity

Unit 3: Insects as Vectors

Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit 4: Dipteran as Disease Vectors

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies

Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes

Study of sand fly-borne diseases –Leishmaniasis,; Control of Sand fly

Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit 5: Siphonaptera as Disease Vectors

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit 6: Siphunculata as Disease Vectors

Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse

Unit 7: Hemiptera as Disease Vectors

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

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
- Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata
- Medical Entomology, Hati A. K Allied Book Agency, Kolkata

GE4P: Insect Vectors and Diseases Lab

Credits 02

List of Practical

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

Or

GE-4: Environment and Public Health

Credits 06

GE4T: Environment and Public Health

Credits 04

Course Contents:

Unit 1: Introduction

Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Dose response evaluation, Exposure assessment.

Unit 2: Climate Change

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

Unit 3: Pollution

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

Unit 4: Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants.

Unit 5: Diseases

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

Suggested Readings:

- 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.

GE4P: Environment and Public Health Lab

Credits 02

List of Practical

To determine pH, Cl, SO₄, NO₃ in soil and water samples from different locations.

Vidyasagar University

Curriculum for B.Sc. (Honours) in Zoology [Choice Based Credit System]

Semester-V

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC- 11		C11T: Molecular Biology	Core Course-11	4	0	0	6	75
		- Lab		0	0	4		
CC- 12		C12T: Genetics	Core Course-12	4	0	0	6	75
		- Lab		0	0	4		
DSE-1		TBD	Discipline Specific Elective - 1	4	0	0	6	75
				0	0	4		
DSE-2		TBD	Discipline Specific Elective -2	4	0	0	6	75
				0	0	4		
Semester Total							24	300

L= Lecture, T= Tutorial, P = Practical, CC - Core Course, TBD - To be decided, DSE: Discipline Specific Elective.

Semester-V

List of Core Course (CC)

CC-11: Molecular Biology

CC-12: Genetics

Discipline Specific Electives (DSE)

DSE-1: Animal Behaviour and Chronobiology

Or

DSE-1: Fish and Fisheries

Or

DSE-1: Reproductive Biology

DSE-2: Animal Biotechnology

Or

DSE-2: Microbiology

Semester-V

Core Courses (CC)

CC-11: Molecular Biology

Credits 06

C11T: Molecular Biology

Credits 04

Course Contents:

Unit 1: Nucleic Acids

Salient features of DNA and RNA. Watson and Crick Model of DNA

Unit 2: DNA Replication

Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, Replication of telomeres

Unit 3: Transcription

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.

Unit 4: Translation

Mechanism 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; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

Unit 6: Gene Regulation

Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon;
Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting

Unit 7: DNA Repair Mechanisms

Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair

Unit 8: Molecular Techniques

PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing

Suggested Readings:

1. Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman.
2. Molecular Biology of the Gene by Watson. 7th Edition. Pearson.

3. iGenetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.

C11P: Molecular Biology (Lab)

Credits 02

List of Practical

1. Demonstration of polytene and lampbrush chromosome from photograph
2. Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement)
3. Agarose gel electrophoresis for DNA

CC-12: Genetics

Credits 06

C12T: Genetics

Credits 04

Course Contents:

Unit 1: Mendelian Genetics and its Extension

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

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and Crossing Over, molecular basis of crossing over, Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence

Unit 3: Mutations

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

Unit 4: Sex Determination

Mechanisms of sex determination in *Drosophila*
Sex determination in mammals
Dosage compensation in *Drosophila* & Human

Unit 5: Extra-chromosomal Inheritance

Criteria for extra chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Kappa particle in *Paramecium* Shell spiralling in snail

Unit 6: Recombination in Bacteria and Viruses

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Unit 7: Transposable Genetic Elements

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

Suggested Readings:

1. Developmental biology by Scott. F. Gilbert, 9th edition.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings
Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.

C12P: Genetics (Lab)

Credits 02

List of Practical

1. Chi-square analyses
2. Linkage maps based on conjugation
3. Identification of chromosomal aberration in Drosophila and man from photograph
4. Pedigree analysis of some human inherited traits

Discipline Specific Electives (DSE)

DSE-1 : Animal Behaviour and Chronobiology

Credits 06

DSE1T : Animal Behaviour and Chronobiology

Credits 04

Course Contents:

Unit 1: Introduction to Animal Behaviour

Origin and history of Ethology, Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

Unit 2: Patterns of Behaviour

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

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

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

Adaptive significance of biological clocks

Unit 5: Biological Rhythm

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 of seasonal reproduction of vertebrates; Role of melatonin.

Suggested Readings:

1. Animal Behaviour by Drickamar.
2. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
3. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
4. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros Patricia J. De Coursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
5. Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barends and Noble Inc. New York, USA
6. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

DSE1P: Animal Behaviour and Chronobiology (Lab)

Credits 02

List of Practical

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 and actogram construction of locomotor activity of suitable animal models.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

Or

DSE-1: Fish and Fisheries

Credits 06

DSE1T: Fish and Fisheries

Credits 04

Course Contents:

Unit 1: Introduction and Classification

General description of fish

Feeding habit, habitat and manner of reproduction

Classification of fish (up to Subclasses)

Unit 2: Morphology and Physiology

Types of fins and their modifications; Locomotion in fish; 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; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fish); Electric organ, Bioluminescence

Unit 3: Fisheries

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

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: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

Unit 5: Fish in research

Transgenic fish

Zebrafish as a model organism in research

Suggested Readings:

1. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
2. 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
3. C.B.L. Srivastava, Fish Biology, Narendra Publishing House J.R. Norman, A history of Fishes, Hill and Wang Publishers
4. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House.

Note: Classification to be followed from: Romar A. S. (1959)

DSE1P: Fish and Fisheries (Lab)

Credits 02

List of Practical

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *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. **Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.**

Or

DSE-1: Reproductive Biology

Credits 06

DSE1T: Reproductive Biology

Credits 04

Course Contents:

Unit 1: Reproductive Endocrinology

Mechanism of action of steroids and glycoprotein hormones. hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female) Reproductive system:

Development and differentiation of gonads, genital ducts and external genitalia

Unit 2: Functional anatomy of male reproduction

Histoarchitecture of testis in human; Spermatogenesis; Kinetics and hormonal regulation; Androgen synthesis and metabolism; Accessory glands functions

Unit 3: Functional anatomy of female reproduction

Histoarchitecture of ovary in human; Oogenesis; Kinetics and hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its Regulation

Unit 4: Reproductive Health

Infertility in male and female: causes, diagnosis and management Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization Modern contraceptive technologies

Suggested Readings:

1. Ross & Pawlina. Histology: A text and Atlas. 6th edition.
2. Guyton & Hall. Medical Physiology. 11th edition.
3. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
4. Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

DSE1P: Reproductive Biology (Lab)

Credits 02

List of Practicals:

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. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
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. Sperm count and sperm motility in rat

DSE-2: Animal Biotechnology

Credits 06

DSE2T: Animal Biotechnology

Credits 04

Course Contents:

Unit 1: Introduction

Organization of prokaryotic and eukaryotic genome, Concept of genomics

Unit 2: Molecular Techniques in Gene manipulation

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, Northern and Western blotting
DNA sequencing: Sanger method
Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms

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

Unit 4: Culture Techniques and Applications

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

Suggested Readings:

1. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
3. Weaver. Molecular Biology of Gene. 5th edition.
4. Primrose & Twyman. Principles of Gene Manipulation and Genomics. 7th edition.

DSE2P: Animal Biotechnology (Lab)

Credits 02

List of Practical

1. Genomic DNA isolation from E. coli
2. Plasmid DNA isolation (pUC 18/19) from E. coli
3. Restriction digestion of plasmid 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. Northern Blotting
 - c. Western Blotting
 - d. DNA Sequencing (Sanger's Method)
 - e. PCR
 - f. DNA fingerprinting
7. **Project report on animal cell culture**

Or

DSE-2: Microbiology

Credits 06

DSE2T: Microbiology

Credits 04

Course Contents:

Unit 1: Introduction to Microbiology

Historical perspective of Microbiology, Prokaryotic pathogens, Eukaryotic pathogens

Unit 2: Bacterial taxonomy

Principles and modern approaches of bacterial taxonomy. Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese

Unit 3: Morphology of Bacteria and Virus

Cell wall (Structure of peptidoglycan), Cell envelope (Cell membrane, Differences between gram-positive and gram-negative species, External capsule and glycocalyx, Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Reserve materials (carbon and phosphate reserve, cyanophycin), Cytoplasmic inclusions (Chlorosome, magnetosome, carboxysome, gas vesicles, ribosome). Structural organization of viruses, Prions and viroids

Unit 4: Normal flora

Distribution of normal flora in the body: Skin, eye, mouth, intestinal tract, urino-genital tract, Beneficial functions of normal flora. Harmful effects of normal flora

Unit 5: Pathogenicity of Microorganisms

Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness, Bacterial toxins Exotoxins, Endotoxins, Antigenic switching. Viral Pathogenesis: Cellular level (Cell death, Transformation, Cell fusion, Cytopathic effect). Initial infections: Routes of entry and dissemination to secondary sites, Typical secondary sites of localization, Virus shedding and mode of transmission; Factors involved in termination of acute infection

Unit 6: Infection of pathogens to human populations

Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic

Unit 7: Diagnostic Microbiology and Bacteria culture

Koch's postulates, Sensitivity and specificity of test results, Principles and applications: Simple staining, Gram-staining, Acid-fast staining, Collection of specimens, Growth requirements and Growth factors, Oxygen requirement. Culture Media: Simple media, Complex media, Selective media and Enriched media

Unit 8: Genetic recombination in bacteria

Transformation, Conjugation- F⁺, F⁻, Hfr & F' strain, Transduction, Generalised & specialized types.

Unit 9: Microbial Diseases

Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of following diseases: Bacterial (Polio, Typhoid, Staphylococcal Food Poisoning), Viral (Dengue, AIDS)

Suggested Readings:

1. Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley and Sons, New York.
2. Atlas, R. M. and Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4th ed.
3. Benjamin/ Cummings. Black, J. G. (2011). Microbiology: Principles and Explorations. 8th ed. John Wiley and Sons, New York.
4. Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell.

5. Pinehuk, G. (2003). Schaum's outline Series: Theory and Problems of Immunology.
6. McGrawHill.
7. Prescott, L. M., Harley, J. P. and Klein, D. A. (2011). Microbiology, 8th ed. McGrawHill, New York.
8. Schlegel, H. G. (1993). General Microbiology. 7th ed. Cambridge University Press.
9. Slonczewski, J.L. and Foster, J.W. (2009). Microbiology- An Evolving Science. Norton.
10. Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L. (1986). General Microbiology. 5th ed. Macmillan.
11. Talaro, K. and Talaro, A. (1999). Foundations in Microbiology. 3rd ed. Dubuque, McGraw Hill.
12. Tortora, G. J., Funke, B. R., and Case. C. L. (2008). Microbiology. An Introduction. 9th ed. Benjamin/Cummings Publishing. Menlo Park Calif.
13. Voyleys, B. A. (2002). The biology of viruses, 2nd ed. McGraw-Hill.

DSE2P: Microbiology (Lab)

Credits 02

List of Practical:

1. Simple staining and Gram's staining of bacteria.
2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria.
3. Preparation of slant and stab.
4. Pure culture techniques: Spread plate, Pour plate and Streak plate
5. Biochemical test for characterization:
Catalase, Nitrate-reduction, Indole production, Methyl Red and Voges-Proskauer Test.
6. Microbiological examination of milk (Methylene blue reductase test).
7. Sugar fermentation test.

Vidyasagar University

Curriculum for B.Sc. (Honours) in Zoology [Choice Based Credit System]

Semester-VI

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC- 13		C13T: Developmental Biology	Core Course-13	4	0	0	6	75
		- Lab		0	0	4		
CC- 14		C14T: Evolutionary Biology	Core Course-14	4	0	0	6	75
		- Lab		0	0	4		
DSE-3		TBD	Discipline Specific Elective - 3	4	0	0	6	75
				0	0	4		
DSE-4		TBD	Discipline Specific Elective -4	4	0	0	6	75
				0	0	4		
Semester Total							24	300

L= Lecture, T= Tutorial, P = Practical, CC - Core Course, TBD - To be decided, DSE: Discipline Specific Elective.

Semester-VI

List of Core Course (CC)

CC-13: Developmental Biology

CC-14: Evolutionary Biology

Discipline Specific Electives (DSE)

DSE-3: Parasitology

Or

DSE-3: Endocrinology

DSE-4: Biology of Insects

Or

DSE-4: Wild Life Conservation and Management

Semester-VI

Core Courses (CC)

CC-13: Developmental Biology

Credits 06

C13T: Developmental Biology

Credits 04

Course Contents:

Unit 1: Introduction

Basic concepts: Phases of Development, Cell cell interaction, Differentiation and growth, Differential gene expression.

Unit 2: Early Embryonic Development

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.

Unit 3: Late Embryonic Development

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).

Unit 4: Post Embryonic Development

Development of brain and Eye in Vertebrate. Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each).

Unit 5: Implications of Developmental Biology 8 Class

Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis.

Suggested Readings:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Publishers, Sunderland, Massachusetts, USA
2. Slack JMW , Essential Developmental Biology Inc.,

C13P: Developmental Biology Lab

Credits 02

List of Practical

1. 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).
2. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
3. Study of different sections of placenta (photomicrograph/ slides).
4. **Project report on *Drosophila* culture/chick embryo development.**

CC-14: Evolutionary Biology

Credits 06

C14T: Evolutionary Biology

Credits 04

Course Contents:

Evolutionary Biology

Unit-1: Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, evolution of eukaryotes.

Unit-2: Historical review of Evolutionary concepts, Lamarkism, Darwinism and Neo Darwinism.

Unit-3: Geological time scale, Fossil records of Hominids (from *Australopithacus* to *Homo sapiens*), evolution of horse. Neutral theory of molecular evolution, Molecular clock.

Unit-4: Sources of variations: Heritable variations and their role in evolution.

Unit-5: Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority). Genetic Drift mechanism (founder's effect, bottleneck phenomenon). Role of Migration and Mutation in changing allele frequencies.

Unit-6: Species concept, Isolating mechanisms, modes of speciation. Adaptive radiation /macroevolution (exemplified by Galapagos finches).

Unit-7: Extinctions, Background and mass extinctions (causes and effects), detailed example of K-T extinction.

Unit-8: Origin and Evolution of Man, Unique Hominin characteristics contrasted with primate characteristic Molecular analysis of human origin.

Unit-9: Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Convergent & Divergent evolution.

Suggested Readings:

1. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
2. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
3. Geneics: A Molecular Approach. 3rd edition. Peter. J. Russell.

C14P: Evolutionary Biology Lab

Credits 02

List of Practical

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. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

Discipline Specific Electives (DSE)

DSE-3: Parasitology

Credits 06

DSE3T: Parasitology

Credits 04

Course Contents:

Unit-1: Introduction to Parasitology

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

Unit-2: Parasitic Protists

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

Unit-3: Parasitic Platyhelminthes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia sajinata*

Unit-4: Parasitic Nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*, *Brugia malayi*; Nematode plant interaction; Gall formation.

Unit-5: Parasitic Arthropods

Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick *Ixodes*), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) and Bug (*Cimex*).

Unit-6: Parasite Vertebrates

Brief account of Cookicutter Shark, Hood Mocking bird, Vampire bat.

Suggested Readings:

1. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors

2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease.
4. Taylor and Francis Group
5. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi
6. Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.
7. Page66Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers.
8. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

DSE3P: Parasitology Lab

Credits 02

List of Practical:

1. Study of life stages of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* through permanent slides/micro photographs.
2. Study of adult and life stages of *Schistosoma haematobium*, *Taenia sajinata* through permanent slides/micro photographs.
3. Study of adult and life stages of *Ancylostoma duodenale*, *Brugia malayi* and *Trichinella spiralis* through permanent slides/micro photographs.
4. Study of plant parasitic root knot nematode, Meloidogyne from the soil sample.
5. Study of *Pediculus humanus*, *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs.
6. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry].
7. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by-product.

Submission of a brief report on parasitic vertebrates.

Or

DSE-3: Endocrinology

Credits 06

DSE3T: Endocrinology

Credits 04

Course Contents:

Unit-1: Introduction to Endocrinology

General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones

Unit-2: Epiphysis, Hypothalamo-hypophysial Axis

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

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Thymus, Adrenal, Pancreas, Ovary and Testis. Hormones in homeostasis, Disorders of endocrine glands

Unit-4: Regulation of Hormone Action

Mechanism of action of steroidal, non-steroidal hormones with receptors. Bioassays of hormones using RIA & ELISA. Estrous cycle in rat and menstrual cycle in human. Multifaceted role of Vasopressin & Oxytocin. Hormonal regulation of parturition.

Suggested Readings:

1. Guyton and Hall. Textbook of Medical Physiology. 13th Edition
2. Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
3. Vertebrate Endocrinology by David O. Norris,

DSE3P: Endocrinology Lab

Credits 02

List of Practical

1. Dissect and display of Endocrine glands in laboratory bred rat.
2. Study of the permanent slides of all the endocrine glands
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
4. Estimation of plasma level of any hormone using ELISA.
5. Designing of primers of any hormone.

DSE-4: Biology of Insects

Credits 06

DSE4T: Biology of Insects

Credits 04

Course Contents:

Unit-1: Introduction

General Features of Insects. Distribution and Success of Insects on the Earth.

Unit-2: Insect Taxonomy

Basis of insect classification; Classification of insects up to orders (according to Brusca and Brusca, 2016).

Unit-3: General Morphology of Insects

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.

Unit-4: Physiology of Insects

Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system. Photoreceptors: Types, Structure and Function Metamorphosis: Types and Neuroendocrine control of metamorphosis.

Unit-5: Insect Society

Social insects with special reference to termites. Trophallaxis in social insects such as ants, termites and bees.

Unit-6: Insect Plant Interaction

Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects, Major insect pests in paddy.

Unit-7: Insects as Vectors

Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors.

Suggested Readings:

1. A general text book of entomology, Imms , A. D., Chapman & Hall, UK
2. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
3. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
4. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M , Saunders College Publication, USA
5. The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
6. Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
7. Physiological system in Insects, Klowden, M. J., Academic Press, USA
8. The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
9. Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA
10. Mosquito, Chandra G (2000), Sribhumi Pub. Co.
11. Medical Entomology, Hati A. K., Allied Book Agency, 2010

[Note: Classification to be followed from IMMS A. D. (1938)]

DSE4P: Biology of Insects Lab

Credits 02

List of Practical

1. Study of life cycle of Mosquito
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Mounting of insect wings, spiracles and genitalia of any insects
4. Methodology of collection, preservation and identification of insects.
5. Morphological studies of various castes of *Apis*, *Camponotus* *Odontotermes*
6. Study of major insect pests of paddy and their damages
7. Study of Mulberry silk moth as beneficial insect

Or

DSE-4: Wild Life Conservation and Management

Credits 06

DSE4T: Wild Life Conservation and Management

Credits 04

Course Contents:

Unit-1: Introduction to Wild Life

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

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

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

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

Unit-5: Aims and objectives of wildlife conservation

Wildlife conservation in India – through ages; different approaches of wildlife conservation; modes of conservation; in-situ conservation and ex-situ conservation: necessity for wildlife conservation.

Unit-6: Management planning of wild life in protected areas

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

Unit-7: Man and Wildlife

Causes and consequences of human-wildlife conflicts; mitigation of conflict – an overview; Management of excess population.

Unit-8: Protected areas

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

Suggested Readings:

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

DSE4P: Wild Life Conservation and Management Lab

Credits 02

List of Practical

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna.
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.
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).

