

# 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
				<b>Total Credits =20</b>				

**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		
	<b>4 Credits</b>	<b>Class</b>
<b>Unit 1: Basics of Animal Classification</b>		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)		
<b>Unit 2: Protista and Metazoa</b>		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> <b>Metazoa</b> Evolution of symmetry and segmentation of Metazoa		

<b>Unit 3: Porifera</b>	6
General characteristics and Classification up to classes; Canal system and spicules in sponges	
<b>Unit 4: Cnidaria</b>	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	
<b>Unit 5: Ctenophora</b>	2
General characteristics	
<b>Unit 6: Platyhelminthes</b>	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>	
<b>Unit 7: Nematoda</b>	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	
<b>Reference Books</b>	
► 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, 6<sup>th</sup> 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
<b>Unit 1: Introduction to Ecology</b>		4
History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
<b>Unit 2: Population</b>		20
Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, 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.		
<b>Unit 3: Community</b>		11
Community characteristics: species diversity, abundance, , dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession with one example		
<b>Unit 4: Ecosystem</b>		10
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains,		

<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>	
<b>Unit 5: Applied Ecology</b>	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 CO<sub>2</sub>
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 ( $\lambda$ ) DNA using EcoR1 and Hind III.
6. Preparation of competent cells and Transformation of E. coli with plasmid DNA using CaCl<sub>2</sub>, 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
				<b>Total Credits =22</b>				

**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, 6<sup>th</sup> 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**

	<b>4 Credits</b>	<b>Class</b>
<b>Unit 1: Protista</b>		<b>3</b>
Protozoa : General characters of Protozoa; Life cycle of <i>Plasmodium</i>		
<b>Unit 2: Porifera</b>		<b>3</b>
General characters and canal system in Porifera		
<b>Unit 3: Radiata</b>		<b>3</b>
General characters of Cnidarians and polymorphism		
<b>Unit 4: Aceolomates</b>		<b>2</b>
General characters of Helminthes		
<b>Unit 5: Pseudocoelomates</b>		<b>3</b>
General characters of Nematoda Parasitic adaptations		
<b>Unit 6: Annelida</b>		<b>3</b>
General characters of Annelida Metamerism		
<b>Unit 7: Arthropoda</b>		<b>4</b>
General characters. Social life in insects.		
<b>Unit 8: Mollusca</b>		<b>4</b>
General characters of mollusk. Pearl Formation		
<b>Unit 9: Echinodermata</b>		<b>4</b>
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
<b>Semester Total</b>							<b>26</b>	<b>350</b>

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:  $\beta$ -oxidation of fatty acids; Fatty acid biosynthesis

**Unit 3: Proteins**

Amino acids

Structure, Classification, General and Electro chemical properties of  $\alpha$ -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
<b>Semester Total</b>							<b>26</b>	<b>350</b>

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](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, SO<sub>4</sub>, NO<sub>3</sub> 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		
<b>Semester Total</b>							<b>24</b>	<b>300</b>

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. 7<sup>th</sup> Edition. W.H. Freeman.
2. Molecular Biology of the Gene by Watson. 7<sup>th</sup> Edition. Pearson.

3. iGenetics: A Molecular Approach by Peter. J. Russell. 3<sup>rd</sup> 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, 9<sup>th</sup> 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<sup>+</sup>, F<sup>-</sup>, 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, 4<sup>th</sup> ed.
3. Benjamin/ Cummings. Black, J. G. (2011). Microbiology: Principles and Explorations. 8<sup>th</sup> 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. McGrawHill.
6. Presscott, 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		
<b>Semester Total</b>							<b>24</b>	<b>300</b>

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, Back ground 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. 3<sup>rd</sup> 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).

