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 *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica* **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 *Obelia* & *Aurelia* Metagenesis in *Obelia* 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 *Fasciola hepatica* and *Taenia solium*	
Unit 7: Nematoda	7
General characteristics and Classification up to classes Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti* 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 *Paramoecium*
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
History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors,Study of Physical factors, The Biosphere.		
Unit 2: Population		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.		
Unit 3: Community		11
Community characteristics: species diversity, abundance, , dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession with one example		
Unit 4: Ecosystem		10
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains,		

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

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

C2 P2 –Ecology Lab Credits 02

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 quadrate 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_2

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

Bio safety Physical and Biological containment

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

GE-1 P1 –Animal Cell Biotechnology Lab Credits 02

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.

<u>Interdisciplinary/Generic Elective (GE) from other Department</u>
[**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

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition
- TheInvertebrates: 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 *Plasmodium*		
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: Echynodermata		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.

GE2 P –Animal Diversity Lab Credits 02

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*, *Icthyophis*/*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, Echeneis, Anguilla, Hippocampus, Tetrodon/ 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