

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

Sem	Core Course(14)	Ability Enhancement Compulsory Course (2)	Skill Enhancement Course SEC (2)	Discipline Specific Elective DCE (4)	Generic Elective GE (4)
I	CC-1: Non-chordates I: Protista to Pseudocoelomates	English/Hindi/MIL Communication			GE-1: Animal Diversity
	CC-2: Principles of Ecology				
II	CC-3: Non-chordates II: Coelomates	Environmental Science			GE-2: Comparative Anatomy and Development Biology of Vertebrates
	CC-4: Cell Biology				
III	CC-5: Diversity of Chordates		SEC-1: Sericulture		GE-3: Human Physiology
	CC-6: Physiology: Controlling and Coordinating Systems				
	CC-7: Fundamentals of Biochemistry				
IV	CC-8: Comparative Anatomy of Vertebrates		SEC-2: Aquarium Fish Keeping		GE-4: Genetics and Evolutionary Biology
	CC-9: Physiology: Life Sustaining Systems				
	CC-10: Biochemistry of Metabolic Processes				
V	CC-11: Molecular Biology			DSE-1: Immunology	
	CC-12: Principles of Genetics			DSE-2: Animal Biotechnology	
VI	CC-13: Developmental Biology			DSE-3: Fish and Fisheries	
	CC-14: Evolutionary Biology			DSE-4: Endocrinology	

Semester	Course Opted	Course Name	Credits
I	Ability Enhancement Compulsory Course-I	English Communications	2
	Core course-1	Non-chordates I: Protista to Pseudocoelomates	4
	Core Course-1 Practical		2
	Core course-2	Principles of Ecology	4
	Core Course-2 Practical		2
	Generic Elective –1	Botany 1/Chemistry 1/Other Discipline	4
	Generic Elective –1 Practical/Tutorial		2
	II	Ability Enhancement Compulsory Course-II	Environmental Science
Core course-3		Non-chordates II: Coelomates	4
Core Course-3 Practical			2
Core course-4		Cell Biology	4
Core Course-4 Practical			2
Generic Elective –2		Botany 2/Chemistry 2/Other Discipline	4
Generic Elective –2 Practical			2
III		Core course-5	Diversity of chordates
	Core Course-5 Practical		2
	Core course-6	Physiology: Controlling and Coordinating systems	4
	Core Course-6 Practical		2
	Core course-7	Fundamentals of Biochemistry	4
	Core Course-7 Practical		2
	Skill Enhancement Course-1	Sericulture	4
	Generic Elective –3	Botany 3/Chemistry 3/ Other Discipline	4
	Generic Elective –3 Practical		2
	IV	Core course-8	Comparative anatomy of vertebrates
Core Course-8 Practical			2
Core course-9		Physiology: Life Sustaining Systems	4
Core Course-9 Practical			2
Core course-10		Biochemistry of Metabolic Processes	4
Core Course- 10 Practical			2
Skill Enhancement Course- 2		Aquarium Fish Keeping	4
Generic Elective –4		Botany 4/Chemistry 4/ Other Discipline	4
Generic Elective – 4 Practical			2
V		Core course-11	Molecular Biology
	Core Course-11 Practical		2
	Core course-12	Principles of Genetics	4
	Core Course-12 Practical		2
	Discipline Specific Elective –1	Immunology	4
	Discipline Specific Elective –1 Practical		2
	Discipline Specific Elective –2	Animal Biotechnology	4
Discipline Specific Elective- 2 Practical/Tutorial		2	

VI	Core course-13	Developmental Biology	4
	Core Course-13 Practical/Tutorial		2
	Core course-14	Evolutionary Biology	4
	Core Course-14 Practical/Tutorial		2
	Discipline Centric Elective –3	Fish and Fisheries	4
	Discipline Centric Elective –3 Practical/Tutorial		2
	Discipline Centric Elective-4	Endocrinology	4
	Discipline Centric Elective –4 Practical/Tutorial		2
		Total:	140

CORE COURSES	
CC-1	Non-chordates I: Protista to Pseudocoelomates
CC-2	Principles of Ecology
CC-3	Non-chordates II: Coelomates
CC-4	Cell Biology
CC-5	Diversity of Chordates
CC-6	Physiology: Controlling and Coordinating Systems
CC-7	Fundamentals of Biochemistry
CC-8	Comparative Anatomy of Vertebrates
CC-9	Physiology: Life Sustaining Systems
CC-10	Biochemistry of Metabolic Processes
CC-11	Molecular Biology
CC-12	Principles of Genetics
CC-13	Developmental Biology
CC-14	Evolutionary Biology

DISCIPLINE SPECIFIC ELECTIVE COURSES	
DSE-1	Immunology
DSE-2	Animal Biotechnology
DSE-3	Fish and Fisheries
DSE-4	Endocrinology
GENERIC ELECTIVE COURSES FOR OTHER DISCIPLINE *(Four papers from any two discipline) the Students of B.Sc. Zoology Honours have to adopt four papers from other two discipline*	
GE-1	Animal Diversity
GE-2	Comparative Anatomy and Development Biology of Vertebrates
GE-3	Human Physiology
GE-4	Genetics and Evolutionary Biology
SKILL ENHANCEMENT COURSES	
SEC-1	Sericulture
SEC-2	Aquarium Fish Keeping

*For pursuing M.Sc. in Zoology, the students should have Chemistry as Generic Elective (GE) for two semesters.

Bodoland University :: Department of Zoology

Curriculum Structures for UG syllabus (*B.Sc. Honours*)

No. of papers =14+12=26, Total Credits= 140

Total Marks = 2400

SEM-I						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-101H	CC-1: Non-chordates I: Protista to Pseudocoelomates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-102H	CC-2: Principles of Ecology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-103HR	GE-1: Animal Diversity	6	4+0+2	60(Theo)+20(Pract)	20	100
COMM-104HR	AEC: AECC-1: English/Hind/MIL (Communication)	2	2+0+0	50	-	50
Total		20	20	290	60	350

SEM-II						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-201H	CC-3: Non-chordates II: Coelomates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-202H	CC-4: Cell Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-203HR	GE-2: Comparative Anatomy and Development Biology of Vertebrates	6	4+0+2	60(Theo)+20(Pract)	20	100
COMM-204HR	AEC: AECC-2: Environmental Science	2	2+0+0	50	-	50
Total		20	20	290	60	350

SEM-III						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-301H	CC-5: Diversity of Chordates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-302H	CC-6: Physiology: Controlling and Coordinating Systems	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-303H	CC-7: Fundamentals of Biochemistry	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-304HR	AEC: SEC-1: Sericulture	2	2+0+0	50	-	50
ZOO-305H	GE-3: Human Physiology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		26	26	370	80	450

SEM-IV						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-401H	CC-8: Comparative Anatomy of Vertebrates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-402H	CC-9: Physiology: Life Sustaining Systems	6	□+0+2	60(Theo)+20(Pract)	20	100
ZOO-403H	CC-10: Biochemistry of Metabolic Processes	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-404HR	AEC: SEC-2: Aquarium Fish Keeping	2	2+0+0	50	-	50
ZOO-405 H	GE-4: Genetics and Evolutionary Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		26	26	370	80	450

SEM-V						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-501H	CC-11: Molecular Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-502H	CC-12: Principles of Genetics	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D1HR	DSE-1: Immunology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D2HR	DSE-2: Animal Bio-technology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		24	24	320	80	400

SEM-VI						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-601H	CC-13: Developmental Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-602H	CC-14: Evolutionary Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D3H	DSE-3: Fish and Fisheries	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D4H	DSE-4: Endocrinology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		24	24	320	80	400

1ST SEMESTER SYLLABUS (HONOURS)

SEM-I						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-101H	CC-1: Non-chordates I: Protista to Pseudocoelomates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-102H	CC-2: Principles of Ecology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-103HR	GE-1: Animal Diversity	6	4+0+2	60(Theo)+20(Pract)	20	100
COMM-104HR	AEC: AECC-1: English/Hind/MIL (Communication)	2	2+0+0	50	-	50
Total		20	20	290	60	350

CC-1: NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

THEORY **(CREDITS 4)**

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

General characteristics and Classification up to classes

Study of *Euglena*, *Amoeba* and *Paramecium*

Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*

Locomotion and Reproduction in Protista

Evolution of symmetry and segmentation of Metazoa

Unit 2: Porifera **7**

General characteristics and Classification up to classes

Canal system and spicules in sponges

Unit 3: Cnidaria **12**

General characteristics and Classification up to classes

Metagenesis in *Obelia*

Polymorphism in Cnidaria

Corals and coral reefs

Unit 4: Ctenophora **4**

General characteristics and Evolutionary significance

Unit 5: Platyhelminthes **10**

General characteristics and Classification up to classes

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

Unit 6: Nematelminthes **8**

General characteristics and Classification up to classes

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

Parasitic adaptations in helminthes

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”

PRACTICALS **(CREDITS 2)**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*

2. Examination of pond water collected from different places for diversity in protista

3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*

4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*

5. One specimen/slide of any ctenophore

6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/ photographs)

7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)

8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CC-2: PRINCIPLES OF ECOLOGY

THEORY **(CREDITS 4)**

Unit 1: Introduction to Ecology **6 Lectures**

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

Unit 2: Population **24**

Unitary and Modular populations

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion
Exponential and logistic growth, equation and patterns, r and K strategies

Population regulation - density-dependent and independent factors

Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit 3: Community **12**

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example

Theories pertaining to climax community

Unit 4: Ecosystem **14**

Types of ecosystems with one 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 one example of Nitrogen cycle

Human modified ecosystem

Unit 5: Applied Ecology **4**

Ecology in Wildlife Conservation and Management

PRACTICALS **(CREDITS 2)**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

SUGGESTED READINGS

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

GE- 1: ANIMAL DIVERSITY

<u>THEORY</u>	(CREDITS 4)
Unit 1: Kingdom Protista	4 Lectures
General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa	
Unit 2: Phylum Porifera	3
General characters and classification up to classes; Canal System in <i>Sycon</i>	
Unit 3: Phylum Cnidaria	3
General characters and classification up to classes; Polymorphism in Hydrozoa	
Unit 4: Phylum Platyhelminthes	3
General characters and classification up to classes; Life history of <i>Taenia solium</i>	
Unit 5: Phylum Nematelminthes	5
General characters and classification up to classes; Life history of <i>Ascaris lumbricoides</i> and its parasitic adaptations	
Unit 6: Phylum Annelida	3
General characters and classification up to classes; Metamerism in Annelida	
Unit 7: Phylum Arthropoda	5
General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects	
Unit 8: Phylum Mollusca	4
General characters and classification up to classes; Torsion in gastropods	
Unit 9: Phylum Echinodermata	4
General characters and classification up to classes; Water-vascular system in Asteroidea	
Unit 10: Protochordates	2
General features and Phylogeny of Protochordata	
Unit 11: Agnatha	2
General features of Agnatha and classification of cyclostomes up to classes	
Unit 12: Pisces	4
General features and Classification up to orders; Osmoregulation in Fishes	
Unit 13: Amphibia	4
General features and Classification up to orders; Parental care	
Unit 14: Reptiles	4
General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes	
Unit 15: Aves	5
General features and Classification up to orders; Flight adaptations in birds	
Unit 17: Mammals	5
Classification up to orders; Origin of mammals	
Note: Classification of Unit 1-9 to be followed from “Barnes, R.D. (1982). <i>Invertebrate Zoology</i> , V Edition”	

PRACTICAL **(CREDITS 2)**

1. Study of the following specimens:
2. *Amoeba*, *Euglena*, *Plasmodium*, *Paramecium*, *Sycon*, *Hyalonema*, and *Euplectella*, *Obelia*, *Physalia*, *Aurelia*, *Tubipora*, *Metridium*, *Taenia solium*, Male and female *Ascaris lumbricoides*, *Aphrodite*, *Nereis*, *Pheretima*, *Hirudinaria*, *Palaemon*, *Cancer*, *Limulus*,

Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis*, Any six common birds from different orders, *Sorex*, Bat, *Funambulus, Loris*

3. Study of the following permanent slides:
4. T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia*, T.S. of Male and female *Ascaris*
5. Key for Identification of poisonous and non-poisonous snakes

An “**animal album**” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

2ND SEMESTER SYLLABUS (HONOURS)

SEM-II						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-201H	CC-3: Non-chordates II: Coelomates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-202H	CC-4: Cell Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-203HR	GE-2: Comparative Anatomy and Development Biology of Vertebrates	6	4+0+2	60(Theo)+20(Pract)	20	100
COMM-204HR	AEC: AECC-2: Environmental Science	2	2+0+0	50	-	50
Total		20	20	290	60	350

CC-3: NON-CHORDATES II: COELOMATES

THEORY	(CREDITS 4)
Unit 1: Introduction to Coelomates	2 Lectures
Evolution of coelom and metamerism	
Unit 2: Annelida	10
General characteristics and Classification up to classes	
Excretion in Annelida	
Unit 3: Arthropoda	17
General characteristics and Classification up to classes	
Vision and Respiration in Arthropoda	
Metamorphosis in Insects	
Social life in bees and termites	
Unit 4: Onychophora	4
General characteristics and Evolutionary significance	
Unit 5: Mollusca	
General characteristics and Classification up to classes, Respiration in Mollusca	
Torsion and detorsion in Gastropoda, Pearl formation in bivalves, Evolutionary significance of trochophore larva	
Unit 6: Echinodermata	12
General characteristics and Classification up to classes, Water-vascular system in Asteroidea, Larval forms in Echinodermata, Affinities with Chordates	

PRACTICAL **(CREDITS 2)**

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

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

SUGGESTED READINGS

Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition

Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science

Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CC-4: CELL BIOLOGY

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

PRACTICAL **(CREDITS 2)**

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. DNA and RNA by MGP
 - c. Mucopolysaccharides by PAS reaction
 - d. Proteins by Mercurobromophenol blue/Fast Green

SUGGESTED READINGS

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

**GE-2: COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF
VERTEBRATES**

<u>THEORY</u>	<u>(CREDITS 4)</u>
Unit 1: Integumentary System	4 Lectures
Derivatives of integument w.r.t. glands and digital tips	
Unit 2: Skeletal System	3
Evolution of visceral arches	
Unit 3: Digestive System	4
Brief account of alimentary canal and digestive glands	
Unit 4: Respiratory System	5
Brief account of Gills, lungs, air sacs and swim bladder	
Unit 5: Circulatory System	4
Evolution of heart and aortic arches	
Unit 6: Urinogenital System	4
Succession of kidney, Evolution of urinogenital ducts	
Unit 7: Nervous System	3
Comparative account of brain	
Unit 8: Sense Organs	3
Types of receptors	
Unit 9: Early Embryonic Development	12
Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.	
Unit 10: Late Embryonic Development	10
Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.	
Unit 11: Control of Development 8	
Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death	

<u>PRACTICAL</u>	<u>(CREDITS 2)</u>
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1. Osteology:
 - a) Disarticulated skeleton of fowl and rabbit
 - b) Carapace and plastron of turtle /tortoise
 - c) Mammalian skulls: One herbivorous and one carnivorous animal.
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Study of placental development in humans by ultrasound scans.
5. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
- Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
- Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc.

3RD SEMESTER SYLLABUS (HONOURS)

SEM-III						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-301H	CC-5: Diversity of Chordates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-302H	CC-6: Physiology: Controlling and Coordinating Systems	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-303H	CC-7: Fundamentals of Biochemistry	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-304HR	AEC: SEC-1: Sericulture	2	2+0+0	50	-	50
ZOO-305H	GE-3: Human Physiology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		26	26	370	80	450

CC-5: DIVERSITY OF CHORDATA

THEORY	(CREDITS 4)
Unit 1: Introduction to Chordates	2 Lectures
General characteristics and outline classification	
Unit 2: Protochordata	8
General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata	
Unit 3: Origin of Chordata	3
Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata	
Unit 4: Agnatha	2
General characteristics and classification of cyclostomes up to class	
Unit 5: Pisces	8
General characteristics of Chondrichthyes and Osteichthyes, classification up to order Migration, Osmoregulation and Parental care in fishes	
Unit 6: Amphibia	6
Origin of <i>Tetrapoda</i> (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians	
Unit 7: Reptilia	7
General characteristics and classification up to order; Affinities of <i>Sphenodon</i> ; Poison apparatus and Biting mechanism in snakes	
Unit 8: Aves	8
General characteristics and classification up to order <i>Archaeopteryx</i> —a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds	
Unit 9: Mammals	8
General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages	
Unit 10: Zoogeography	8
Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms	

PRACTICAL **(CREDITS 2)**

- 1. Protochordata**
Balanoglossus, *Herdmania*, *Branchiostoma*, Colonial Urochordata Sections of *Balanoglossus* through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania* spicules
- 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**
Ichthyophis/Ureotyphlus, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*
- 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. Aves**

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

7. **Mammalia**

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

Mount of weberian ossicles of *Mystus*, pecten from Fowl head

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

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

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

SUGGESTED READINGS

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrímsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.2015

CC-6: ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

THEORY **(CREDITS 4)**

Unit 1: Tissues **6 Lectures**

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

Unit 2: Bone and Cartilage **4**

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

Unit 3: Nervous System **10**

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

Unit 4: Muscle **12**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 5: Reproductive System **10**

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

Unit 6: Endocrine System **18**

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

PRACTICALS **(CREDITS 2)**

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

(*Subject to UGC guidelines)

SUGGESTED BOOKS

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

CC-7: FUNDAMENTALS OF BIOCHEMISTRY

THEORY **(CREDITS 4)**

Unit 1: Carbohydrates **8 Lectures**

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

Unit 2: Lipids **8**

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

Unit 3: Proteins **14**

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

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

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants

Unit 4: Nucleic Acids **12**

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

Cot Curves: Base pairing, Denaturation and Renaturation of DNA, Types of DNA and RNA, Complementarity of DNA, Hypo-Hyperchromaticity of DNA

Unit 5: Enzymes **18**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme

-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max} , Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition;

Allosteric enzymes and their kinetics; Regulation of enzyme action

PRACTICAL **(CREDITS 2)**

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

SUGGESTED READING

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

SEC-1: SERICULTURE

THEORY

(CREDITS 2)

Unit 1: Introduction

(3 Lectures)

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

(3)

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

(13)

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

(4)

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

(2)

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

SUGGESTED READINGS

- Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co.Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

GE-3: HUMAN PHYSIOLOGY

THEORY **(CREDITS 4)**

Unit 1: Digestion and Absorption of Food **12 Lectures**

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

Unit 2: Functioning of Excitable Tissue (Nerve and Muscle) **10**

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

Unit 3: Respiratory Physiology **6**

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

Unit 4: Renal Physiology **8**

Functional anatomy of kidney, Mechanism and regulation of urine formation

Unit 5: Cardiovascular Physiology **10**

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

Unit 6: Endocrine and Reproductive Physiology **14**

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

PRACTICAL **(CREDITS 2)**

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

SUGGESTED READINGS

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

4TH SEMESTER SYLLABUS (HONOURS)

SEM-IV						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-401H	C-8: Comparative Anatomy of Vertebrates	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-402H	C-9: Physiology: Life Sustaining Systems	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-403H	C-10: Biochemistry of Metabolic Processes	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-404HR	AEC: SEC-2: Aquarium Fish Keeping	2	2+0+0	50	-	50
ZOO-405 H	GE-4: Genetics and Evolutionary Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		26	26	370	80	450

CC-8: COMPARATIVE ANATOMY OF VERTEBRATES

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

PRACTICAL	(CREDITS 2)
1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs	
2. Disarticulated skeleton of Frog, <i>Varanus</i> , Fowl, Rabbit	
3. Carapace and plastron of turtle /tortoise	
4. Mammalian skulls: One herbivorous and one carnivorous animal	
5. Dissection of rat to study arterial and urinogenital system (subject to permission)	
6. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)	
7. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)	

SUGGESTED READINGS

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

CC-9: ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

THEORY **(CREDITS 4)**

Unit 1: Physiology of Digestion **14 Lectres**

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

Unit 2: Physiology of Respiration **12**

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

Unit 3: Renal Physiology **8**

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

Unit 4: Blood **14**

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

Unit 5: Physiology of Heart **12**

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

PRACTICALS **(CREDITS 2)**

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 frog's heart beat under *in situ* and perfused conditions*
6. Recording of blood pressure using a sphygmomanometer
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

(*Subject to UGC guidelines)

SUGGESTED READINGS

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

CC-10: BIOCHEMISTRY OF METABOLIC PROCESSES

THEORY

(CREDITS 4)

Unit 1: Overview of Metabolism

10 Lectures

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

Unit 2: Carbohydrate Metabolism

16

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

Unit 3: Lipid Metabolism

14

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

Unit 4: Protein Metabolism

10

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

Unit 5: Oxidative Phosphorylation

10

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

PRACTICALS

(CREDITS 2)

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
6. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO₂ in the TCA cycle

SUGGESTED READINGS

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

SEC – 2: AQUARIUM FISH KEEPING

THEORY

(CREDITS 2)

Unit1: 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

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

GE-4: GENETICS AND EVOLUTIONARY BIOLOGY

THEORY	(CREDITS 4)
Unit 1: Introduction to Genetics	3 Lectures
Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information	
Unit 2: Mendelian Genetics and its Extension	8
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance	
Unit 3: Linkage, Crossing Over and Chromosomal Mapping	9
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping	
Unit 4: Mutations	7
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations	
Unit 5: Sex Determination	4
Chromosomal mechanisms, dosage compensation	
Unit 6: History of Life	2
Major Events in History of Life	
Unit 7: Introduction to Evolutionary Theories	5
Lamarckism, Darwinism, Neo-Darwinism	
Unit 8: Direct Evidences of Evolution	5
Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	
Unit 9: Processes of Evolutionary Change	9
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection	
Unit 10: Species Concept	6
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)	
Unit 11: Macro-evolution	5
Macro-evolutionary Principles (example: Darwin's Finches)	
Unit 12: Extinction	6
Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution	
PRACTICAL	(CREDITS 2)
1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.	
2. Study of Linkage, recombination, gene mapping using the data.	
3. Study of Human Karyotypes (normal and abnormal).	
4. Study of fossil evidences from plaster cast models and pictures	
5. Study of homology and analogy from suitable specimens/ pictures	
6. Charts:	
a. Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors	
b. Darwin's Finches with diagrams/ cut outs of beaks of different species	

7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

5TH SEMESTER SYLLABUS (HONOURS)

SEM-V						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-501H	CC-11: Molecular Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-502H	CC-12: Principles of Genetics	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D1HR	DSE-1: Immunology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D2HR	DSE-2: Animal Bio-technology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		24	24	320	80	400

CC-11: MOLECULAR BIOLOGY

THEORY **(CREDITS 4)**

Unit 1: Nucleic Acids **4 Lectures**

Salient features of DNA and RNA

Watson and Crick model of DNA

Unit 2: DNA Replication **12**

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres

Unit 3: Transcription **10**

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

Unit 4: Translation **12**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA **6**

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

Unit 6: Gene Regulation **10**

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting

Unit 7: DNA Repair Mechanisms **3**

Pyrimidine dimerization and mismatch repair

Unit 8: Regulatory RNAs **3**

Ribo-switches, RNA interference, miRNA, siRNA

PRACTICAL **(CREDITS 2)**

1. Study of Polytene chromosomes from Chironomous / *Drosophila* larvae
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*
3. Estimation of the growth kinetics of *E. coli* by turbidity method
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A₂₆₀ measurement)
7. Quantitative estimation of RNA using Orcinol reaction
8. Study and interpretation of electron micrographs/ photograph showing
 - a) DNA replication
 - b) Transcription
 - c) Split genes

SUGGESTED READINGS

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

CC-12: PRINCIPLES OF GENETICS

THEORY

(CREDITS 4)

Unit 1: Mendelian Genetics and its Extension

8 Lectures

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

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

12

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

Unit 3: Mutations

10

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

Unit 4: Sex Determination

4

Chromosomal mechanisms of sex determination in *Drosophila* and Man

Unit 5: Extra-chromosomal Inheritance

6

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

Unit 6: Polygenic Inheritance

3

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

Unit 7: Recombination in Bacteria and Viruses

9

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Unit 8: Transposable Genetic Elements

8

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

PRACTICALS

(CREDITS 2)

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

SUGGESTED READINGS

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

DSE- 1: IMMUNOLOGY

THEORY **(CREDITS 4)**

Unit 1: Overview of Immune System **10 Lectures**

Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity **10**

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

Unit 3: Antigens **8**

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

Unit 4: Immunoglobulins **10**

Structure and functions of different classes of immunoglobulins, Antigenantibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis

Unit 5: Major Histocompatibility Complex **6**

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation

Unit 6: Cytokines **4**

Properties and functions of cytokines, Therapeutics Cytokines

Unit 7: Complement System **4**

Components and pathways of complement activation.

Unit 8: Hypersensitivity **3**

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

Unit 9: Vaccines **5**

Various types of vaccines.

PRACTICAL **(CREDITS 2)**

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. Ouchterlony's double immuno-diffusion method.
5. ABO blood group determination.
6. *Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of :
 - a) ELISA
 - b) Immunoelectrophoresis

* The experiments can be performed depending upon usage of animals in UG courses.

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kubly, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.

- Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

DSE-2: ANIMAL BIOTECHNOLOGY

THEORY

(CREDITS 4)

Unit 1. Introduction

8 Lectures

Concept and scope of biotechnology

Unit 2. Molecular Techniques in Gene manipulation

24

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

DNA micro array

Unit 3. Genetically Modified Organisms

18

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.

Production of transgenic plants: *Agrobacterium* mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4. Culture Techniques and Applications

10

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular

diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia) Recombinant

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

PRACTICAL

(CREDITS 2)

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

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics*. V Edition, John Wiley and Sons Inc.

6TH SEMESTER SYLLABUS (HONOURS)

SEM-VI						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
ZOO-601H	CC-13: Developmental Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-602H	CC-14: Evolutionary Biology	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D3H	DSE-3: Fish and Fisheries	6	4+0+2	60(Theo)+20(Pract)	20	100
ZOO-D4H	DSE-4: Endocrinology	6	4+0+2	60(Theo)+20(Pract)	20	100
Total		24	24	320	80	400

**CORE COURSE CC-13
DEVELOPMENTAL BIOLOGY**

THEORY **(CREDITS 4)**

Unit 1: Introduction

4 Lectures

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

Unit 2: Early Embryonic Development

28

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

8

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

12

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories

Unit 5: Implications of Developmental Biology

8

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

PRACTICALS **(CREDITS 2)**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicrograph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

SUGGESTED READINGS

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

CC-14: EVOLUTIONARY BIOLOGY

THEORY **(CREDITS 4)**

Unit 1: **7 Lectures**

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

Unit 2: **4**

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

Unit 3: **10**

Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock ,example of globin gene family, rRNA/cyt c

Unit 4: **8**

Sources of variations: Heritable variations and their role in evolution

Unit 5: **13**

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

Unit 6: **7**

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

Unit 7: **2**

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

Unit 8: **6**

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

Unit 9: **2**

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

PRACTICALS **(CREDITS 2)**

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

SUGGESTED READINGS

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

DSE-3: FISH AND FISHERIES

THEORY

(CREDITS 4)

UNIT 1: Introduction and Classification:

6 Lectures

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

UNIT 2: Morphology and Physiology:

18

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

UNIT 3: Fisheries

12

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

Unit 4: Aquaculture

20

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

4

Transgenic fish, Zebrafish as a model organism in research

PRACTICAL

(CREDITS 2)

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. Demonstration of induced breeding in Fishes (video)
8. Demonstration of parental care in fishes (video)
9. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

SUGGESTED READINGS

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

DSE- 4: ENDOCRINOLOGY

THEORY

(CREDITS 4)

Unit 1: Introduction to Endocrinology

12 Lectures

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

Unit 2: Epiphysis, Hypothalamo-hypophysial Axis

15

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

Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms Structure of pituitary gland, Hormones and their functions, Hypothalamohypophysial portal system, Disorders of pituitary gland.

Unit 3: Peripheral Endocrine Glands

18

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

Hormones in homeostasis, Disorders of endocrine glands

Unit 4: Regulation of Hormone Action

15

Hormone action at Cellular level: Hormone receptors, transduction and regulation
Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action

PRACTICAL

(CREDITS 2)

1. Dissect and display of Endocrine glands in laboratory bred rat*
2. Study of the permanent slides of all the endocrine glands
3. Compensatory ovarian/ adrenal hypertrophy *in vivo* bioassay in laboratory bred rat*
4. Demonstration of Castration/ ovariectomy in laboratory bred rat*
5. Estimation of plasma level of any hormone using ELISA
6. Designing of primers of any hormone

SUGGESTED READINGS

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