

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
OOTY ROAD, MYSURU
PG DEPARTMENT OF ZOOLOGY
Syllabus from the academic year 2018-19

Semester	HC / SC	Paper title	CREDITS			Total Credits
			L	T	P	
I	HC - 1.1	Biosystematics & Non Chordata	2	0	2	4
	HC - 1.2	Biological Chemistry	2	0	2	4
	HC - 1.3	Cytogenetics	2	0	2	4
	SC - 1.4	Tools and techniques in Biology	3	1	0	4
	SC - 1.5	Chronobiology	3	1	0	4
	SC - 1.6	Histology and Histopathology	3	0	1	4
Any two of the Soft core paper may be opted						20
II	HC - 2.1	Chordata	2	0	2	4
	HC - 2.2	Animal Physiology	2	0	2	4
	HC - 2.3	Entomology	2	0	2	4
	SC - 2.4	Developmental Biology	3	0	1	4
	SC - 2.5	Immunology	3	1	0	4
	SC - 2.6	Evolutionary Biology	3	1	0	4
Any two of the Soft core paper may be opted						20
III	HC - 3.1	Molecular Biology & Biotechnology	2	0	2	4
	HC - 3.2	Reproductive Biology	2	0	2	4
	HC - 3.3	Ecology and Wildlife**	2	0	2	4
	SC - 3.4	Ethology *	3	1	0	4
	SC - 3.5	Pollution and Toxicology *	3	1	0	4
	OE - 3.6	concepts of Zoology	3	1	0	4
*Any one of the Soft core paper may be opted ** Field visits are included in this paper						20
IV	HC - 4.1	Advanced Genetics and Computational Biology	2	0	2	4
	HC - 4.2	Applied Zoology*	2	0	2	4
	HC - 4.3	Project	0	2	6	8
* Field visits are included in this paper						16

Total credits

Hard Core - 52 Credits

Soft Core - 20 Credits

Open Elective - 04 Credits

Total credits required to complete M.Sc Course - 76 Credits

M.Sc, I SEMESTER
HC 1.1 Biosystematics & Non Chordata

32hrs
8 hrs

UNIT I Basic concepts of animal taxonomy:

- A. Introduction and history of taxonomy
- B. Species concept
- C. Zoological classification - theories of classification - taxonomic ranks – hierarchy
- D. Zoological nomenclature: Binomial nomenclature, trinomial nomenclature-ICZN
- E. taxonomical keys: key to the species
- F. Linnaean taxonomy and classical taxonomy - level of taxonomy.

Unit II : Classification, Locomotion and Nutrition:

8 hrs

- A. General Characteristics of Non chordata.
- B. **Locomotion:** Muscle filaments and myonemes, Flagella and cilia. Amoeboid movement.
- C. **Nutrition in Protozoa:** Filter feeding in polychaetes, Filter feeding and digestion in Deuterostomia and molluscs.
- D. **Respiration:**
Structure and function of respiratory organs- Skin, gills, book lungs and Trachea. Respiratory pigments

Unit III:

8 hrs

- A. **Excretion and osmoregulation:**
Osmoregulation in fresh water and marine Invertebrates
Structure and function of excretory organs- Coelom, Coelomoducts, Nephridia, Malpighian tubules and Coxal glands
- B. **Nervous system:**
Primitive nervous system: Coelenterata and Echinodermata
Advanced nervous system: Annelida, Arthropoda(Crustacea and insecta) and Mollusca (Cephalopod)
- C. Sense organs and their importance

Unit IV:

8 hrs

- A. **Invertebrate paleontology and larval forms:**
Free living and parasitic Larval forms
- B. **Fossil:** types and importance of fossil study, overview of Geological Time Scale

NON CHORDATA –PRACTICALS

4x16=64 Hrs

1. PROTOZOA;

4x12=48 hrs

Slides : 1) *Trypanosoma cruzi* 2) Plasmodium – signet ring stage 3) Ceratium
4) *Leishmania donovani* 5) Vorticella 6) Noctiluca 7) Radiolaria 8) *Entamoeba histolytica*
9) Foraminifera 10) Opalina

2. PORIFERA;

- a) Slides: 1)Sponge spicules 2)Sponge gemmules
- b) Specimen: 1) Grantia 2) Euspongia

3. CNIDARIA:

- a) Slides: 1) Obelia polyp and Medusa 2) Pennaria 3) Aurelia-tentaculocyst
- b) Specimens: 1) Physalia 2) Gorgonia 3) Spongodus 4) Zoanthus 5) Favia 6) Pennatula
7)Sea anemone 8) *Corallium rubrum*

4. HELMINTHES:

- a) Slides: 1) *Fasciola hepatica* 2) *Ancylostoma*
- b) Specimens: 1) Planaria 2) Male and female *Ascaris lumbricoides* 3) *Taenia solium* 4)

5. ANNELIDA:

- a) Slides: 1) Leech 2) Earthworm setae
- b) Specimens: 1) Neries 2) *Chloea flava* 3) *Pheretima postuma* 4) Terebella 5) Eurythoe

6. ARTHROPODA:

- a) Slides: 1) Daphnia 2) Sacculina 3) T.S of Peripatus
- b) Specimens: 1) Balanus 2) Lepas 3) Palinurus 4) Scolopendra 5) Rhinoceros beetle
- 6) Spider 7) Gongylus 8) Belostoma 9) Limulus 10) Squilla 11) Eupagarus 12) Julus

7. MOLLUSCA :

- Specimens: 1) Aplysia 2) Glochidium 3) Loligo 4) Chiton 5) Cypraea 6) Octopus
7) Sanguinolaria 8) Chicoreus 9) Ficus 10) Lambis 11) Mytilus 12) Doris 13) Onchidium
14) Oliva 15) Murex 16) Turritella 17) Cardium

8. ECHINODERMATA:

- Specimens: 1) Sea Urchin 2) Linckia 3) Echinodiscus 4) Holothuria 5) Antedon

9. MINOR PHYLA: —1) Lingula

10. LARVAL FORMS:

- Slides: 1) Cercaria 2) Trochophore 3) Megalopa larva 4) Nauplius 5) Zoea 6) Mysis
7) Phyllosoma 8) Protozoa 9) Bipinnaria 10) Veliger 11) Tornaria
12) Glochidium 13) Pluteus

11. Field Study: Visit to different areas around the college campus, to observe and study

Non chordates in their natural habitat. **4x2=8 hrs**

II. Study of Nervous system, Respiratory system, Reproductive system and Excretory system

in invertebrates by employing computer animation/charts: **4x2=8 hrs**

REFERENCES :

1. Barnes, R.D. 1974. Invertebrate Zoology, III edition. W.B Saunders Co., Philadelphia
2. Barrington, E.J.W, 1976. Invertebrate Structure and Function. Thomas Nelson and Sons Ltd., London.
3. Hyman L.H. 1940. The invertebrates. Vol. 1. Protozoa through Ctenophora, McGraw hill Co., N.Y.
4. Hyman. L H. 1959. The Invertebrates smaller coelomate groups, Vol. V. McGraw Hill Co.,
5. Hyman. L. H. 1951. The Invertebrates. Vol. 2. McGraw Hill Co., N.Y.
6. Hyman. L H. 1968. The invertebrates Vol. 8. McGraw Hill Co., N.Y and London.
7. Simpson, G C. Principles of Taxonomy.

**M.Sc, I SEMESTER
HC -1.2 BIOLOGICAL CHEMISTRY**

32 hrs

UNIT I Chemical Bonds and Carbohydrates:

8 Hrs

- A. Structure of an atom, orbitals, chemical bonds - covalent, co-ordinate, ionic and hydrogen; Vander-Waal's force; hydrophobic interactions; Normality and Molarity of solutions.
- B. Carbohydrates – Chemistry and biological properties

UNIT II Proteins and Lipids:

8 Hrs

- A. Proteins- Chemistry and biological properties, Christian Anfinsen's experiment, Biological values of proteins
- B. Lipids: Chemistry, triglycerides; prostaglandins and steroids –biosynthesis, Chemical importance of lipids.

UNIT III Enzymes:

8 Hrs

- A. Enzymes: Nomenclature – current status; factors influencing velocity of enzyme reaction, enzyme dynamics and enzyme inhibition. Ribozymes and abzymes; co-enzymes, isozymes, clinical importance.

UNIT IV Nucleic acids & Vitamins:

8 Hrs

- A. Nucleic acids: Chemistry, alternative models of DNA,
- B. Vitamins and trace elements – chemical nature, vitamins as co-enzymes, Deficiency diseases, role of trace elements

Biological Chemistry practicals

4x16=64 Hrs

1. Qualitative analysis for identification of carbohydrates (Starch, Glycogen, Sucrose, Lactose, Maltose, Glucose, Fructose).
2. Qualitative analysis for identification of Proteins (Egg albumin, Casein, Gelatin, Peptone)
3. Precipitation reaction of proteins (Egg albumin, Peptone)
4. The absorbance curves for two dyes and demonstration of Beer-Lambert's law.
5. Estimation of amino acids by Sorenson's formal titration (Arginine, Alanine, Leucine, lysine)
6. Determination of concentration of Glucose and Maltose by calibration curve.
7. Determination of amylase activity.
8. Determination of effect of temperature, pH and incubation period on amylase activity.
9. Test for non-esterified fatty acid.
10. Demonstration of gel electrophoresis.

REFERENCES

1. Barrington, E. J. W (1976) An introduction to general and comparative endocrinology, Oxford University press, London.
2. Conn, E. E., Stumpt, P. K., Bruencing, G. and Dol, R. G. 1995. Outlines of Biochemistry. Pub. John Wiley, Singapore.
3. Eckert, R and Randall, D. 2002, Animal physiology, 2nd Edn, W.H..Freman
4. Guyton. A.G. 1986, Text book of Medical Physiology, 7th Edn., Saunders Publication
5. Harper, H. A. 1993. A review of Physiological Chemistry, Lange Medical Publication, 2nd Edn.
6. Lehninger, A. L., Nelson, D. L. and Cox, M. M., 2nd Edn. 1993. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
7. Oser, B. L. (Ed.) 1993. Hawk's Physiological Chemistry. Tata Graw Hill Publishing Co. Ltd. New Delhi.

**M.Sc., I SEMESTER
HC – 1.3 CYTOGENETICS**

32 Hrs

Unit I: Introduction to the Cell & Cell Organelles

8 hrs

- A. The origin and evolution of the cell, From molecules to first cell, from Prokaryotes to eukaryotes, from single cell to multicellular organisms.
- B. Membrane Structure and Function,
- C. Structural organization and functions of intracellular organelles- The nucleus, Mitochondria, Lysosomes, Peroxisomes, Golgi apparatus, and endoplasmic reticulum.

Unit II: Cell Cycle and Cell signalling

8 Hrs

- A. Phases of cell cycle.
- B. Biochemical studies with oocytes, eggs and early embryos.
- C. Regulation of cell cycle: Molecular mechanisms regulating mitotic events.
 - Regulation of cell cycle progression.
 - Check points in cell cycle regulation.
 - Cell cycle control in polytene cells.
- D. Molecular basis of signal transduction
- E. Cellular aging and death: (a) Causes of aging
 - (b) Cellular changes due to aging
 - (c) Theories of aging
 - (d) Apoptosis
 - (e) Longevity genes

UNIT III Gene mutations

8 Hrs

- A. Types of mutations (Spontaneous, Induced, Base substitutions and frameshifts - Transitions, Transversions, gain in function, loss in function, Neutral mutations),
- B. Molecular mechanism of mutations (Base analogs, alkylating agents); Detection of mutations: Dominant lethal test, Sex-linked recessive lethal test, II-III translocations, Ames test, P-mediated mutagenesis

UNIT IV Chromosomal mutations

8 Hrs

- A. Structure and organization of eukaryotic chromosomes
- B. Structural and numerical variations of chromosomes, Chromosomal rearrangements and their cytogenetic consequences with examples from plants, *Drosophila* and Man, Practical applications of chromosome rearrangements - Balancers and attached X-chromosome in *Drosophila*. Cytogenetic effects of ionizing and nonionizing radiations

CYTOGENETICS PRACTICALS

4X16 =64 Hrs

- 1) Life cycle of *Drosophila melanogaster* 1x4=04hrs
- 2) Preparation of culture media. Culture of *Drosophila* - Methods of maintenance. 1x4=04hrs
- 3) Study of morphology of *Drosophila melanogaster* 1x4=04hrs
- 4) Mounting of Sex comb of *Drosophila melanogaster* 1x4=04hrs
- 5) Mounting of Wing of *Drosophila melanogaster* 1x4=04hrs
- 6) Study of mutants of *D. melanogaster* 1x4=04hrs
- 7) Preparation of genital plate of *D. melanogaster* 2x4=08hrs
- 8) Chi square Analysis of F1, F2 and Test cross progeny in *Drosophila melanogaster* to understand pattern of inheritance of different characters and to demonstrate. 3x4=12hrs
 - a) Law of segregation
 - b) Law of Independent assortment
 - c) Sex-linked inheritance

- 9) Temporary squash preparation of Mitotic chromosomes from root tip meristem of *Allium cepa*
2x4=08hrs
- 10) Temporary squash preparation of Meiotic chromosomes from testis of *Poicelocerus pictus*
2x4=08hrs
- 11) Study of Barr body using buccal smear of volunteers
1x4=04hrs

REFERENCES:

1. Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter 2008. Molecular Biology of the cell. V Ed. Garland Science, New York.
2. Brachet, J. 1985. Molecular Cytology, Academic Press, N. Y.
3. Furukawa, R., and M. Fechheimer. 1997. The structure, function and assembly of actin filament bundles. Int. Rev. Cytol. 175: 29-90.
4. Lewin B. (1997) Gene VI Oxford University Press, Oxford
5. Lodish, H., A. Berk, C.A Kaiser, M.P. Scott, A Bretscher, H. Ploegh, P. Matsudaira. 2008. Sixth Edition, Molecular Cell Biology. W. H. Freeman and Co., N. Y.
6. Pollard, T. D. and W. C. Earnshaw. 2002. Cell Biology. Saunders
7. Russel P.J (1998) Genetics. The Benjamin Cummings Publishing Co Inc.
8. Snustad D.P and M.J.Simons. (1997) Principles of Genetics. John Wiley and Sons Inc. N.Y.
9. Strickberger M.W. (1977) Genetics. MacMillan Collier Co. Pvt Ltd
10. Watson J.D, Hopkins, N.H, Roberts J.A, Steitz and A.M.Weiner. (1987) Molecular biology of gene. The Benjamin Cummings Publishing Co Inc.
11. Wolfe, A. 1995. Chromatin: Structure and function. Academic Press, N. Y.

M.Sc., I SEMESTER
SC – 1.4 TOOLS AND TECHNIQUES OF BIOLOGY

48 hrs

UNIT I: MICROSCOPY:

12hrs

Basic principles of microscopy, Types of microscopes and their biological applications
Bright-field microscope, numerical aperture, limit of resolution, types of objectives, ocular & stage micrometers, Electron Microscope, SEM, Confocal microscope.

Dark-field microscope

Phase-contrast microscope

Differential interference contrast microscope

Fluorescence microscope

Photomicrography and image processing

UNIT II: SEPARATION TECHNIQUES:

12hrs

Centrifugation - Basic principles, Types of rotors, Clinical, high speed & ultracentrifuge

Electrophoresis – Agarose and polyacrylamide gel, Two-dimensional, Isoelectrofocussing

Chromatography - Paper and Thin layer chromatography, Column chromatography, Gel filtration, Ion-exchange, Affinity, Introduction to FPLC and HPLC

UNIT III:

12hrs

A. Radio-tracer techniques

Unit of radioactivity and half life, Measurement of radioactivity (β and γ emission), Applications of radioisotopes, Safety measures

B. Techniques in immunodetection: Immunoblotting and immunofluorescence

C. Immunological techniques: Immunodiffusion and Immunoelectrophoresis

UNIT IV:

12hrs

A. Cell culture techniques: Design and functioning of tissue culture laboratory; Culture media, essential components and preparation; Cell viability testing

B. Cytological techniques: Mitotic & Meiotic chromosome preparations from insects and vertebrates Chromosome banding techniques (G-, C-, Q-, R- banding etc.)

C. Molecular cytological techniques: In situ hybridization (radiolabelled & non-radiolabelled methods), FISH, and Restriction banding

D. Molecular biology techniques: Southern hybridization and Northern hybridization DNA sequencing Polymerase chain reaction (PCR)

TUTORIALS

2x16 = 32 Hrs

REFERENCES

1. Alberts et al: Molecular Biology of the Cell, Garland, 2002
2. Karp: Cell and Molecular Biology, John Wiley & Sons, 2002
3. Lodish et al: Molecular Cell Biology, Freeman, 2000
4. Pollard & Earnshaw: Cell Biology, Saunders, 2002
5. Ruthman: Methods in Cell Research, Bell & Sons, 1970.
6. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.), Benjamin/Cumin, 1993
7. Freifelder: Physical Biochemistry (2nd Ed.), Freeman, 1982
8. Holme and Peck: Analytical Biochemistry (3rd Ed.), Tata McGraw Hill, 1998
9. Plumer: An Introduction to Practical Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
10. Switzer and Garrity: Experimental Biochemistry 92nd Ed.), Freeman, 1999
11. Wilson and Walker: Practical Biochemistry (3rd Ed.), Cambridge Univ. Press, 2000

M.Sc., I SEMESTER
SC – 1.5 CHRONOBIOLOGY

48 hrs

UNIT I: Introduction:

4 hrs

History, Biological rhythms, Biological clocks, Significance of biological timekeeping

UNIT II: Biological rhythms:

10 hrs

- A. Types of rhythms- Circadian, Circatidal, Circalunar, Circannual
- B. Methods of measurement
- C. Properties: Entrainment, Re-entrainment, Phase angle difference, Freerun, Phase shift, Phase response curve, Arrhythmia.

UNIT III: Factors influencing biological rhythms:

10 hrs

- A. Environmental: Photoperiod -Photoreception and photo-transduction;
The physiological clock and measurement of day length;
Role of photic and non-photic cues in seasonality, Other zeitgebers
Reversal of roles of principal and supplementary cues.
- B. Evolution of photoperiodism: comparative studies; Circannual rhythms and seasonality.

UNIT III: Circadian pacemaker system:

8 hrs

- A. Suprachiasmatic nuclei, B. Pineal gland, C. Optic lobes.

UNIT IV: Molecular basis of circadian rhythms

8 hrs

- A. Clock genes, B. Drosophila, C. Mouse

UNIT V: Applied Chronobiology:

8 hrs

- A. Human circadian rhythms: Melatonin: Input or output signal of the clock system, Clock function (dysfunction); Human health and diseases
- B. Applications of circadian rhythm principles: Jet-lag/shift work, Depression and sleep disorders, Chronopharmacology and Chronotherapy

TUTORIALS

2X16=32 Hrs

References

1. Binkley, S. (1990): The clockwork sparrow: time, clocks, and calendars in biological organisms, Prentice-Hall, New Jersey.
2. Chandrashekar, M. K. (1985): Biological rhythms, Madras Science Foundation, Chennai.
3. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004: Chronobiology Biological Timekeeping, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
4. Nelson, R. J. (2000) An Introduction to Behavioural Endocrinology, 2nd edition, Sunderland Publishers, Massachusetts.
5. Saunders D.S., C.G.H. Steel, X., afopoulou (ed.)R.D. Lewis. (3rd Ed) 2002: Insect Clocks, Barends and Noble Inc. New York, USA
6. Shapiro, C. M. and Heslegrave, R. J. (1996): Making the shift work, Joli Joco Publications, Inc. Toronto.
7. Vinod Kumar (ed 2002) : Biological Rhythms Narosa Publishing House, Delhi/ Springer-Verlag, Germany

M.Sc., I SEMESTER
SC – 1.6 HISTOLOGY AND HISTOPATHOLOGY

UNIT – I Basics of Histology	48 Hrs
A. Objectives and applications	8Hrs
B. Tissue fixation : Objectives, methods, chemical fixatives-types and chemistry of fixation; Physical methods:-freezing and microwave fixation; choice of fixatives, fixation artifacts.	
C. Dyes. –Natural and Synthetic, Classification	
UNIT-II Functional Morphology (mammalian)	8 Hrs
A. Histological organization of GI tract- stomach and intestine,	
B. Histological organization of lungs & kidney	
C. Histological organization of spleen & thymus,	
D. Bone and bone marrow.	
Unit-III Histochemistry	8 Hrs
A. Principles and methods of application	
B. Classical histochemical Techniques: for localization of glycoproteins (PAS), nucleic acids (Feulgen) and steroid dehydrogenase activity.	
Unit-IV Immunohistochemistry	8 Hrs
A. Principles, method of application	
B. Immunohistochemistry techniques for localization of proteins in endocrine cells (Pituitary cell types or islet of Langerhans)	
C. Immunofluorescence: In situ hybridization of nucleic acids	
UNIT-V Histopathology	8 Hrs
A. Morphological alterations in cells due to disease,	
B. Types of degeneration: clouding, hyaline, hydrophic and fatty degeneration.	
C. Etiology, pathogenesis and histopathology of Liver cirrhosis and atherosclerosis	
D. Neuropathology of alcoholism and methanol poisoning.	
Unit-VI Histopathology of tumors	8 Hrs
A. Malignant and non-malignant	
B. Types of carcinoma	
C. histopathology of breast and prostate tumors	
PRACTICALS	2x8= 16 Hrs
I. Histology:	
1. Microtomy and staining: Hematoxylin-eosin - Demonstration	2x2=4 hrs
2. Histology:	2x2=4 hrs
Observations of permanent slides of mammalian organs – stomach, intestine, spleen, liver, kidney, lungs, testis, epididymis, vas deferens, ventral prostate, seminal vesicle, ovary, uterus and Fallopian tube.	
II. Histometry:	2x3=6hrs
Histometrical measurements and statistical analysis of some tissues.	
III. Histopathology:	2x1=2hrs
Study of histopathological changes (permanent slides) – gastric ulcers, cirrhosis of liver, breast tumors, cystic follicles of ovary, pancreas in diabetics, cryptorchid testis and leukemia.	

REFERENCES:

1. Boyd,W. 1976:A text book of Pathology. Structure and function in disease, 4th edition. Lea and Fibiger, Philadephia.
2. Pearse, A.G.E. (1980): Histochemistry, theoretical and Applied ,J & A, Churchill Ltd., London.
3. Rogers, A.W.(1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.
4. Telford, I.R. and Bridgman,C.F.(1990). Introduction to Functional Histology, Harper and Row, NY.

**M.Sc., II SEMESTER
HC – 2.1 CHORDATA**

32 Hrs

UNIT I General characters and outline classification of Chordata

8hrs

- A. General and Comparative study: Comparison of three Protochordates, Subphyla in terms of General comparison, Habits and habitats,
- B. Alimentary canals and associated glands, Pharynx, Food and feeding and excretory system in Protochordates.
- C. Adaptive radiation in vertebrates – fishes, amphibians, reptiles, aves and mammals

UNIT II

8hrs

- A. **Integument and its Derivatives:** Epidermal Integument or Skin Functions, Structure & its Derivatives (Glands, Scales and scutes, digital cornifications, horns, feathers, hairs), Integument in different classes of Chordates.
- B. **Nervous system-** Development of Brain, spinal cord, Peripheral nerves and sense organs

UNIT III

8hrs

- A. **Respiratory System:** Introduction Respiratory organs: Gills (Internal or true gills, External or Larval gills). Lungs and Ducts, Accessory Respiratory organs and Swim Bladders.
- B. **Circulatory system:** Evolution of heart and aortic arches

UNIT IV

8hrs

- A. **Digestive System:** Introduction Embryonic Digestive Tract Alimentary Canal: Divisions, Digestive Glands
- B. **Urogenital System:** Vertebrate kidneys and ducts, Gonads and their ducts

CHORDATA PRACTICALS

4x16=64 Hrs

1. **Protochordates:** Specimens: 1) *Amphioxus*, *Herdmania*

Slides- *Salpa* (sexual), *Doliolum*

2. **Fishes :** 1) *Rhinobatus* 2) *Hippocampus* 3) Goldfish (aquarium fish) 4) *Clarius*

5) *Anabas* 6) *Coffe* fish 7) *Acipenser* 8) *Periophthalmus* 9) *Triacanthus*

10) *Notopterus* 11) *Exocoetus* 12) *Diodon hystrix* 13) *Echeneis neucrates*

3. **Amphibians :** 1) *Ichthyophis* 2) *Axolotl* Larva 3) *Rana tigrina* 4) *Amblystoma*

4. **Reptiles :** 1) *Calotes* 2) *Mabuya* 3) Chameleon 4) *Phrynosoma* 5) *Chelone mydas*

5) *Varanus* 6) *Naja naja* 7) *Krait* 8) *Hydrophis* 9) *Viper*

5. **Birds :** 1) *Blue jay* 2) *Indian koel* -male and female 3) *Kite*

6. **Mammals :** 1) *Guinea pig* 2) *Domestic cat* 3) *Loris* 4) *Megaloderma lyra* (bat)

5) *Pangolin*

7. **Integuments of vertebrates:** Scales of fish, Hoofs, nails, horns, claws,

plastron and carapace of tortoise, snout of saw fish

8. Osteology :

- 1) **Skull and lower jaw:-** a) Crocodile b) Bird c) Carnivore mammal (dog)
d) Herbivore mammal (horse)
- 2) **Types of vertebrae:-** a) Procoelous b) Ophisthocoelous c) Amphicoelous
d) Amphiplatian e) Heterocoelous f) Axis and atlas vertebrae.

II. Study of following systems in rat by employing computer animation/charts:

- a) Circulatory system b) Nervous system c) Reproductive system
- d) Digestive system e) Sense organs f) Urinary system

REFERENCES :

1. Alexander, R. M. 1975. The Chordata. Cambridge University Press, London.
2. Barrington, E.J.W. 1965. The Biology of Hemichordata and Protochordata, Oliver and Boyd, Edinburgh.
3. Colbert, E. H, 1969. Evolution of the vertebrates, John Wiley and Sons, Inc., N.Y.
4. Kent, C. G. 1954. Comparative anatomy of vertebrates
5. Kingsley, J.S. 1962. Outlines of Comparative anatomy of vertebrates. Central book depot Allahabad.

M.SC., II SEMESTER
HC – 2.2 ANIMAL PHYSIOLOGY

32 Hrs

UNIT I: Membrane Transport, Bioenergetics & Circulation

8 Hrs

A. Membrane Transport:

Molecular mechanisms of passive and active transport.

B. Bioenergetics:

- a) Energy – Concept, laws of thermodynamics
- b) Redox potential
- c) Stepwise release of energy through cytochromes, production of ATP, uncoupling of oxidative phosphorylation, inhibitors.
- d) Anaerobic and aerobic breakdown of glucose, alternate pathway – HMP shunt and glucuronic acid pathway.
- e) Citric acid cycle as common metabolic pathway.

C. Circulation:

- a) Major types of body fluids and their composition.
- b) Neurogenic and myogenic hearts.
- c) Mammalian heart – cardiac cycle, ECG.

UNIT II: Physiology of excitation & Excretion

8 Hrs

A. Muscle Physiology:

- a) Molecular organization of sarcomere.
- b) Mechanism of contraction with emphasis on sliding filament and Davies models, regeneration of storage phosphate.
- c) Physiological adaptations of muscles for jumping, swimming and flight.

B. Neurophysiology:

- a) Axonal and synaptic transmission of nerve impulses.
- b) Synaptic integrity, synaptic plasticity.
- c) Molecular mechanism of sensory transduction and neural output in receptor cells.

C. Excretion:

- a) Comparative physiology of excretion in animals- Nitrogenous wastes and waste elimination.
- b) Mammalian kidney- Structure and physiology of urine formation.

Unit III: Basic Concepts of Endocrinology

8 hrs

A. Chemical messengers:

Autocrine, Paracrine and endocrine secretions,
Types of hormones, an overview of human endocrine system

B. Hormone synthesis: Peptide and steroid hormones.

Role of Hormones in homeostasis- Glucose and Water balance

C. Hypothalamus and pituitary gland:

Structure, function and control of hypothalamic hormones.
Pituitary hormones and their physiological actions
chemical structure and. Feedback regulation. Pathophysiology.
Hypothalamo - hypophysial portal system

D. Pineal gland–Structure and function.

Unit IV:**8 hrs**

- A. Thyroid gland:** Structure, function and biosynthesis of thyroid hormone
- B. Parathyroid :** Structure and PTH – Calcitonin – Role of hormones in calcium and phosphate metabolism.
- C. Adrenal gland hormones**
 - Adrenal cortex hormones:** Corticoids: role played in Stress management – Aldosterone and the rennin- angiotensin system
 - Adrenal medullary hormones:** Catecholamines as emergency hormones
- D. Gastrointestinal hormones:** Secretion, control and function
- E. Pancreatic Hormones:** Insulin and glucagons, their role in the regulation of Carbohydrate, protein and lipid metabolisms.

ANIMAL PHYSIOLOGY PRACTICALS**4x16=64 Hrs**

1. Estimation of Proteins by Lowry *et al* method. (in tissue sample from slaughter house)
2. Determination of serum cholesterol. (Clinical sample)
3. Determination of glucose content by Anthrone method. ((in tissue sample from slaughter house)
4. Estimation of liver and skeletal muscle glycogen. (in tissue sample from slaughter house)
5. Determination of serum/ blood urea by DAMO method. (Clinical sample)
6. Estimation of creatinine in the urine sample.
7. Total count of RBC and WBC.
8. Differential count of WBC
9. Response of RBC's to Hypertonic, hypotonic and isotonic solutions
10. Observation of permanent slides of T.S of endocrine glands
 - a. Pituitary gland b. Thyroid gland c. Adrenal gland d. Pancreas
11. Identification of chemical structures of steroid hormones

REFERENCES:

1. Adler N. T (1981) Neuroendocrinology of Reproduction, Physiology and Behaviour. Austin, C. R and R. V. Short (eds) (1972) Reproduction in mammals. (1) Germ cells and Fertilization (2) Embryonic and Foetal development (3) Hormones in Reproduction (4) Reproduction pattern (5) Artificial control of reproduction, Cambridge University press, London.
2. Barrington, E. J. W (1976) An introduction to general and comparative endocrinology, Oxford University press, London
3. Raghavendra Puri (2003) Mammalian endocrinology Vol. I & II, Dominant Publishers and Distributors, New Delhi.
4. Eckert, R and Randall, D. 2002, Animal physiology, 2nd Edn, W.H. Freeman
5. Guyton. A.G. 1986, Text book of Medical Physiology, 7th Edn., Saunders Publication

M.Sc., II SEMESTER
HC – 2.3 ENTOMOLOGY

- 32hrs**
10 hrs
- Unit I: General Entomology**
- A. Classification of class Insecta up to orders with suitable examples; Integument appendages.
- B. Insect Endocrinology**
- I. Insect Hormones and their regulation: Chemistry and functions of hormones, Hormones in metamorphosis, Ecdysis and Diapause
- II. Semiochemicals: Allelochemicals and Pheromones (Primer & releaser)
- 10hrs**
- Unit II: Agricultural Entomology**
- A. Role of insects in plant pollination
- B. Insects pests: Classification and categories of pests, origin and emergence of pests, pest out breaks and pest resurgence
Structure, life history, significance, nature of damage and control methods of major pests of sugarcane, Paddy and Coconut.
- C. Structure, life history, significance, nature of damage and control measures of stored grain pests: (a) *Sitophilus* (b) *Trogoderma* (c) *Rhizopertha* (d) *Tribolium* (e) *Bruchus* (f) *Sitotrua* (g) *Ephestia*
- 06hrs**
- Unit III: General and household insect pests**
- A. Structure, life history, significance, nature of damage and control measures of following general pests: (a) grasshoppers & locusts (c) termites (d) aphids (e) hairy caterpillars
- B. Household pests: Cockroaches, Ants, Wasps, Silverfish, furniture beetle, and their control
- 06hrs**
- Unit IV: Medical Entomology**
- A. Insect vectors: Role of insect as vectors of human diseases (Malaria, filariasis, Kala azar and their control)
Mosquitoes as pests and their control.
Housefly: A human health hazard and its control
- B. Arboviral diseases: Dengue, chicken gunya, swine flu.
- PRACTICALS:** **4x16=64 Hrs**
1. Collection and preservation of dead insects for systematic studies & field report 4x4=16 hrs
2. Identification of different insects upto orders- House fly, Cockroach :
Mosquitoes, stored grain beetles, destructive insects, important crop and household pests
4x4=16 hrs
4. Fixing and preservation of dead insects by Plastination technique. 4x4=16 hrs
5. Field studies of insects to understand their habit: Ants, Butterflies, termite, wasps, Moths.
4x2=08 hrs
6. Study of insect mouth parts: Mosquito, Cockroach, House fly, Butterfly 4x2=08 hrs
- REFERENCES:**
1. Awasti V.B. 2009 Introduction to general entomology 3rd Ed. Scientific publication (India), Jodhpur
2. Awasti V.B. 2007, Agricultural Insect Pests and their control. Scientific publishers (India) Jodhpur
3. Trigonayat M.M. 2009, A Manual of practical entomology, scientific publishers, Jodhpur, India.
4. Dhaliwal G.S. Ramsingh and B.S. Chillar 2006, Essentials of Agricultural entomology. Kalyani Publishers, New Delhi.
5. L . K Jha. Applied Agricultural Entomology. New central book agency. Culcutta

M.Sc., II- SEMESTER
SC – 2.4 DEVELOPMENTAL BIOLOGY

48 Hrs

Unit I:

- A) Introduction : Descriptive V/s. Experimental Embryology **8hrs**
B) Fertilization : a) An overview of structure and differentiation of egg and sperm
b) General sequence and molecular events during fertilization

Unit II: Early development - I

8 hrs

- a) Nucleocytoplasmic interactions in early development: An overview of Nuclear transplantation experiments in Amphibians and mammals
b) Creations of multicellularity: Cleavage-Regulatory mechanism
c) Gastrulation: Morphogenetic movements and regulatory mechanisms in amphibian and mammalian embryo.

Unit III: Early development - II

8hrs

- a) Morphogenetic determinants and their role in development:
Yellow cytoplasm in Ascidians, Polar body in Mollusca, Pole plasm in *Drosophila*
b) Laying down the embryonic body plan :
Determination of embryonic axes in *Drosophila* – Anterior-posterior (maternal effect genes) & Dorsoventral; Amphibians (cell-cell interaction) & Mammals (Hox Genes)
c) Cell lineage studies and cell death genes in *Caenorhabditis elegans*.

Unit IV: Morphogenesis –I

8 hrs

- a) Early embryogenesis in *Drosophila* : Regional specification by. Segmentation genes: Gap genes, Pair rule genes, Segment polarity genes, and Homeotic genes.
b) Cellular differentiation and morphogenesis:
i. Neuronal v/s epidermal fate specification in *Drosophila*.
ii. Vulval induction in *Caenorhabditis elegans*.

Unit V: Morphogenesis-II

8 hrs

- a) Role of Cell Adhesion molecules in morphogenesis : Cadherins and Fibronectins
b) Genetics of imaginal discs and transdetermination
c) Limb development-an over view :
i. Proximo-distal axis specification in developing limb.
ii. Cell death and formation of digits.

Unit VI: Post embryonic development

8 hrs

- a) Metamorphosis : Endocrine and molecular control of metamorphosis in insects and amphibians b) Types of growth c) Regeneration : Types, Blastema formation, Sources of cells for regeneration d) Abnormal development as seen in Teratogenesis.

PRACTICALS

16X2=32Hrs

1. Study of internal changes during early development of frog & chick (permanent slides) 3X2=06hrs
2. Development of chick-Embryo mounting-permanent preparation 2X2=04hrs
3. Study of early developmental stages of *Drosophila* (Live Observation of embryo) and dechoriation and observation of embryos 2X2=04hrs
4. Study of Imaginal discs – the precursors of adult structures in *Drosophila* 3X2=06hrs
5. Demonstration of window technique to observe chick embryo development 2X2=04hrs
6. Effect of thyroid hormone on development in frog 2X2=04hrs
7. Study of various developmental stages in frog up to tadpole stage 2X2=04hrs

REFERENCES:

1. Balinsky, B.I., 1965. An introduction to embryology, W.B.Saunders company.
2. Gilbert, S. F. 2006, Developmental Biology, 8th Ed.Sinauer Associates Inc.,
3. Kalthoff, 2000, Analysis of Biological Development, 2nd Ed., McGraw-Hill Science, New Delhi, INDIA. Massachusetts, USA.
4. Vasudeva Rao, 1994. Developmental Biology: A modern synthesis, Oxford & IBH, New Delhi.
5. Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006) Principles of Development, , Oxford University Press, New Delhi, INDIA.
6. Wolpert, L, Beddington, R Jessell, T. Lawrence P, Meyerowitz, E, Smith J., 2001, Principles of Deveopment Oxford University Press Oxford.
7. Ann Kiessling and Scott C. Anderson, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, 2003. Jones and Bartlett Publishers, Boston MA, USA

**M.Sc., II SEMESTER
SC – 2.5 IMMUNOLOGY**

48hrs

Unit I: Introduction to immunity

8hrs

- A. History; types of immunity – Innate and acquired immunity.
- B. Cells and Organs of immune system: Cells: Lymphocytes (T & B cells), monocytes, macrophage; eosinophils, basophils, neutrophils and mast cells.
- C. Primary and secondary lymphoid organs: Bone marrow, Thymus, Spleen, Lymph nodes

Unit II: Antigens and Immunoglobulins

8hrs

- A. Antigens: factors influencing immunogenicity, adjuvant, epitope, hapten
- B. Immunoglobulins: Basic structure of the immunoglobulin;
Types and functions of immunoglobulins.
- C. Monoclonal antibodies:Antigen-antibody reactions

Unit III: Immune response

8hrs

- A. Humoral and cell mediated immune responses
- B. Primary and secondary immune modulation; Cytokines; role of complement system in immune response (Classical pathway, Alternate pathway);
- C. Immune response against bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections;

Unit IV Immunotechniques

8hrs

- A. Agglutination; Precipitation;
- B. Immunofluorescence; RIA, ELISA, Immuno-electrophoresis and Western blotting.

Unit V Major histocompatibility complex and Hypersensitivity

8hrs

- A. Transplantation and graft rejection,
- B. Genetic organization of H2 and HLA complexes, HLA typing;
- C. Immediate and delayed hypersensitivity.

Unit VI Vaccines and Vaccination

8hrs

- A. Types of Vaccines and their significance
- B. Vaccine delivery systems.
- C. Congenital and acquired immunodeficiencies

TUTORIALS

2X16=32 Hrs

References:

1. Austyn, J.M. and Kathym, J. Wood. 1993. Principles of cellular and molecular Immunology. Oxford University Press. Oxford.
2. Benjamin, Elisunshine, Geoffrey Leskowitz.1996. Immunology: A short course. 3rd Edition. New York.
3. Kubey, J.M. 1990. Essential Immunology. 6th Edition. Blackwell Scientific Publication, New York.
4. Rao, C.V. 2002. An introduction to Immunology. Narona Publishing House, New Delhi.
5. Rotti, I. 1994. Essential Immunology. Blackwell, London.
6. Stibes, D.P. and Terr, A.I. 1991. Basic and Clinical Immunology. 7th Edition. Appleton and Large. California.

M.Sc., II SEMESTER
SC – 2.6 EVOLUTIONARY BIOLOGY

	48 Hrs
UNIT I Emergence of concept of evolution:	8 Hrs
A. Pre Darwinian concepts, Darwinism and its impact in the development of synthetic theory.	
B. Neodarwinism: Birth of population genetics, Components of population genetics, Mendelian population, gene pool, allele frequencies and genotype frequencies,	
UNIT II Speciation:	8 Hrs
A. Concept of species,	
B. Types of species	
C. Models of speciation,	
D. Patterns and mechanisms of reproductive isolation,	
E. Hybridization, polyploidy and speciation.	
UNIT III Molecular evolution	8 Hrs
A. Phyletic gradualism and punctuated equilibrium.	
B. Micro and macroevolution.	
C. Molecular evolution: Selectionists theory of evolution, Neutral theory of evolution and Molecular clock and emergence of non-darwinism,	
UNIT IV Phylogeny	8 Hrs
A. Phylogenetic trees : Construction with nucleic acid and amino acid sequences,	
B. Types of trees and Techniques employed in construction of phylogenetic trees,	
C. Molecular phylogenetics of Homo sapiens.	
UNIT V Population genetics and Evolution	8 Hrs
A. Gene pool, gene frequency, Hardy-Weinberg Law.	
B. Destabilizing forces of evolutionary equilibrium (Mutation, Migration, Selection, Meiotic drive and genetic drift).	
C. Founder effect, Isolating mechanisms and speciation.	
D. Micro Macro and Mega evolution, Co-evolution.	
UNIT VI Genome and Evolution	8 Hrs
A. Genes and gene clusters	
B. Origin of new genes by gene duplication (Ohno's concept)	
C. Selfish DNA	
D. Karyotypic evolution (Drosophila).	

TUTORIALS **2X16=32Hrs**

REFERENCES:

1. Dobzhansky Th, (1951) Genetics and origin of species, 3rd Edn. Chapman and Hall, London.
2. Dobzhansky Th, Ayala F.J, Stebbins G.L and J.M. Valentine, (1976) Evolution, Surjeet Publication, New Delhi.
3. Futuyama D.J (1986) Evolutionary Biology, Sinuauer Associates Inc. USA
4. Hartl D.L (2000) A primer of population genetics, Sinuauer Associates Inc. USA
5. Jha A.P (1992) Genes and Evolution - John Wiley Publicaion, New Delhi
6. King M (1993) Species evolution - The role of chromosomal change. The Cambridge University Press, Cambridge

M.Sc., III SEMESTER
HC – 3.1 MOLECULAR BIOLOGY AND BIOTECHNOLOGY

32 hrs

Part A: Molecular Biology

Unit I Introduction to nucleic acids

8hrs

- A. DNA Replication: i) Enzyme components of replication unit ii) Mechanism with emphasis on Dna A in initiation, Co-ordinated synthesis, End replication in eukaryotes iii) Fidelity.
- B. Transcription: i) Transcription apparatus and process (RNA polymerase, cis-regulatory elements, terminators, transcription factors). ii) Post transcriptional modifications of mRNA in eukaryotes (G-cap, PolyA tail, Splicing).
- C. Translation: i) Genetic code (major features, usage of different codons). ii) Enzymes, factors and the process (Aminoacyl t-RNA synthetase, Peptidyl transferase, IFs, EFs, RFs and Ribosome)

Unit II Gene regulation

8hrs

- A. Gene regulation in Prokaryotes: (i) Regulation at transcription initiation: Eg. lac operon (+ve and -ve control) (ii) Regulation beyond transcription initiation: trp attenuator (iii) Regulation in Lambda Phage - Lytic and lysogenic cycle induction.
- B. Gene regulation in Eukaryotes: (a) Transcriptional activators (b) Transcriptional repression: (i) direct repression, indirect repression (ii) Gene silencing by modification of histones and DNA (c) RNA interference
- C. Molecular basis of homologous recombination: Models and protein machinery
- D. Molecular mechanisms of DNA damage repair.

Part B: Biotechnology

Unit III:

8 hrs

A. Genetic engineering:

Definition, objectives and outline of recombinant DNA technology procedure.

Enzymes: Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase.

Cloning vectors: Plasmids, Phages, Cosmids, Phagemids, Artificial chromosomes (YAC, BAC, HAC),

B. Cloning:

Construction of Genomic and cDNA libraries.

Identification of Recombinants: Genetic selection, Use of chromogenic substrates, Insertional activation.

Analysis of recombinant DNA clones: Characterization of clones, Restriction mapping, Southern hybridization.

Polymerase chain reaction and DNA sequencing-Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing

Unit IV:

8 hrs

C. Applications of Biotechnology:

Production of medically important products – vaccines, Gene therapy, AIDS therapy, Biofertilizers, biopesticides, medicine and human health

D. Animal Biotechnology

Animal cell and Tissue culture: Principles of cell culture, cell and tissue types, cell lines, transformation.

Cell and tissue culture media: Natural and defined, role and components of serum in culture.

Applications of tissue culture: Tissue culture in biomedical research karyological studies, amniocentesis, mutagenesis, Cytotoxicity assays.

PRACTICALS

4x16=64 Hrs

1. Extraction of DNA by rapid method.
2. Extraction of DNA by standard method.
3. Estimation of DNA concentration by Diphenylamine method.
4. Localization of DNA in prefixed paramecium slides by Feulgen staining
5. Localization of nucleic acids in prefixed paramecium slides by Toluidine blue staining
6. Estimation of RNA concentration by Orcinol method
7. PCR amplification of DNA and gel electrophoresis.
8. Restriction digestion and gel electrophoresis.
9. Isolation of plasmid DNA from bacteria.
10. Molecular biology problems

REFERENCES

1. Griffiths A J F, H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart 2000. An introduction to genetic analysis. W. H. Greeman. New York.
2. Lewin, B 2003 Genes VIII. Oxford University Press. Oxford
3. Dale, Jeremy W and Schantz, Malcom V. 2002. From Gene to Genomes. John Wiley and Sons Ltd, NY, USA
4. Das, H.K. 2007. Text book of Biotechnology. Wiley India Pvt. Ltd. New Delhi
5. Freshney, Ian, R. 2006. Culture of Animal Cell (5th edn). Wiley- Liss publications
6. Pandian, T.T. and Kandavel, D. 2008. Text Book of Biotechnology. I.K International Publishing House, New Delhi. 47
7. Primrose, S.B., Twyman, R.M., and Old, R.W. 2001. Principle of Gene Manipulation (6th edn). Blackwell Science Ltd, London
8. Singh .B.D. 2006. Biotechnology. Kalyani Publishers, New Delhi
9. Sobti, R. C. and Pachauri, Suparna S. 2009. Essentials of Biotechnology. Ane Books Pvt. Ltd. New Delhi

M.Sc., III SEMESTER
HC – 3.2 REPRODUCTIVE BIOLOGY

32 hrs

UNIT I: Male reproduction:

8 hrs

- A. Functional morphology of male reproductive system
- B. Kinetics of spermatogenesis – wave and cycle
- C. Hormonal control of mammalian testis and spermatogenesis
- D. Ultrastructure of spermatozoa
- E. Abnormalities of sperm
- F. Brief description of histomorphology and hormonal control of male accessory organs viz., epididymis, vas deferens, seminal vesicles, ventral prostate, bulbourethral gland and preputial gland
- G. Sperm maturation – morphological and biochemical events, influence of accessory organ secretions
- H. Biochemistry of semen and capacitation

UNIT – II Female reproduction:

8 hrs

- A. Origin and migration of primordial germ cells; genetic and hormonal control of differentiation of gonads and gonadal ducts in mammals.
- B. Female Reproductive System-Functional morphology of mammalian ovary, Fallopian tube and uterus.
- C. Ovarian steroid hormones and their actions

UNIT III: Reproductive cycles in Mammals:

8 hrs

- A. Comparison of estrous and menstrual cycles
- B. Menstrual cycle : Different phases, changes in the ovary and uterus and hormonal control
- C. Implantation – Process, Types and hormonal control
- D. Pregnancy – length of gestation, hormonal control
- E. Parturition – Process of birth and influence of hormones
- F. Lactation – Hormonal control of mammary gland, development and lactogenesis

UNIT – IV: Fertility and reproductive management

8 hrs

- A. Fertility control – Need, principles of different male and female temporary and permanent contraceptive methods.
- B. Assisted Reproduction: Causes of infertility, Artificial insemination, different methods of assisted reproduction (*In-vitro* Fertilization, Gamete Intra Fallopian tube Transfer, Zygote Intra Fallopian tube Transfer).

PRACTICALS

16X4=64 hrs

1. Demonstration of surgical technique by video clipping
2. Counting of spermatozoa in semen sample collected from volunteers
3. Staining of spermatozoa for abnormalities in semen samples collected from volunteers /clinical samples
4. Study of different contraceptive devices
5. Observation of permanent Histology slides
 - a. Comparative morphology of ovary
 - b. Comparative morphology of testis
 - c. Comparative study of male accessory organs
 - d. Comparative study of female accessory organs
6. Observation of permanent slides of T.S of endocrine glands
 - a. Pituitary gland
 - b. Thyroid gland
 - c. Adrenal gland
 - d. Pancreas

REFERENCES

1. Adler N. T (1981) Neuroendocrinology of Reproduction, Physiology and Behaviour.
2. Austin, C. R and R. V. Short (eds) (1972) Reproduction in mammals. (1) Germ cells and Fertilization (2) Embryonic and Foetal development (3) Hormones in Reproduction (4) Reproduction pattern (5) Artificial control of reproduction, Cambridge University press, London.
3. Barrington, E. J. W (1976) An introduction to general and comparative endocrinology, Oxford University press, London
4. Raghavendra Puri (2003) Mammalian endocrinology Vol. I & II, Dominant Publishers and Distributors, New Delhi.
5. Muneeth Kainth (2005) Chordate Embryology, Dominant Publishers and Distributors, New Delhi.
6. Moudgal, N. R. Yoshinaga K Rao, A. J. and P. R. Adiga (1991) Perspectives in primate reproductive biology. Wiley Eastern Ltd., New Delhi, Bangalore
7. Paul Wassar man and Jimmy D. Neill (2005) Knogbil and neill's physiology of reproductive volume 1st and 2nd and 3rd edition
8. Jones, R. E (1991) Human Reproductive Biology press N.Y
9. Knobil, E and Neil J. D (1994) The physiology of reproduction, Vol. I & II. Raven press, New York.

M.Sc., III SEMESTER
HC – 3.3 ECOLOGY AND WILDLIFE

32 hrs

Part-A Ecology

UNIT - I

8 hrs

A. Ecosystem: Historical account, Scope, Basic concepts and Approaches to the study of Environmental Biology. Components of Environment - An overview of abiotic factors and Biotic factors. Concepts of habitat and Ecological niche. Ecotone and Edge effect. Food chains, Food-webs and their structure in Ecological Pyramids in aquatic, terrestrial and parasitic Environments.

B. Population Ecology: Introduction. An overview of important population attributes – Density, Natality, Growth rates, Growth forms and concept of carrying capacity, Patterns in human population growth and its explosion -Remedial measures. Mortality - life tables and survivorship curve, sex ratio, age distribution, dispersal and dispersion, aggregation and Allee's principle, population fluctuation and cyclic oscillations and Population interactions.

UNIT - II

8 hrs

A. Community Ecology Concept of community - community structure and attributes, concept of climax Species diversity in community and it's measurement- Alpha diversity- Simpson's diversity index, Shannon index, Fisher's alpha, rarefaction. Beta diversity- Sorensen's similarity index, Whittaker's index, Evenness, Gamma diversity. Drivers of species diversity loss and conservation.

B. Bioecology of Freshwater Zooplankton: Definition, Types and adaptations of Zooplankton. Brief study of organizations, life cycles and Ecological importance of Rotifers, Cladocerans, Copepods-Calanoids, Harpacticoids and Cyclopoids, and Ostracods. Mass culturing of Zooplankton.

C. Microbial Ecology: Ecological role, beneficial and pathogenic Microorganisms. Indicator Microorganisms. Role of microorganisms in biodegrading and bioremediation of organic and metal pollution.

Part B Wildlife Biology

UNIT – III

8hrs

- A.** Scope and values of wildlife (Ecological, Aesthetic, Scientific, Recreational, Medicinal)
- B.** Causes of wildlife depletion: Degradation and destruction of natural habitats, Exploitation for commercial purposes, Deforestation, Agricultural expansion, Urbanization and Industrialization, forest fires and hunting.
- C.** Wildlife corridors, Human-wildlife conflicts
- D.** Wildlife awareness and education, Wildlife and tribal welfare

UNIT – IV

- A.** Conservation strategies: Red data book, protected area network, Role of NGOs in conservation.
- B.** Wildlife act and legislation: Wildlife Protection Act 1972; Biological Diversity Act 2002.
- C.** Wildlife conservation projects in India (with special reference to Project Tiger, Project Hungul and Gir Project)
- D.** In-situ conservation: Bioreserves, National parks, Wildlife sanctuaries and Safari's in India
- E.** Management of Bioreserves, National parks, Wildlife sanctuaries and Safari.
- F.** Ex-situ conservation: Zoo garden, Management of Zoos, Captive breeding, Artificial insemination, Cryopreservation (techniques and applications) Germplasm banks,

PRACTICALS:**4X16=64 Hrs**

1. Qualitative and Quantitative study of freshwater planktons.
2. Determination of species diversity by Shannon-Weiner Index
3. Determination of species diversity by Simpson's index
4. Field visit to Sewage pond, Natural lake (and if possible river): Collection of water samples and study of physico-chemical parameters such as colour, pH, temperature, conductivity, total solids and turbidity
5. Estimation of Dissolved Oxygen in three natural (sewage, pond and Tap) water samples.
6. Estimation of free Carbon di-Oxide in three natural (sewage, pond and Tap) water samples.
7. To study the relationship between Dissolved Oxygen and free Carbon di-Oxide, if any, in three natural (sewage, pond and Tap) water samples.
8. Determination of BOD in three natural (sewage, pond and Tap) water samples
9. Determination of COD in three natural (sewage, pond and Tap) water samples
10. To study the relationship between BOD and COD, if any, in three natural (sewage, pond and Tap) water samples
11. Collection, observation of planktons (Phytoplankton and Zooplankton) from polluted and non-polluted water bodies.
12. Estimations of bacterial abundance in different water samples – using DMT.
13. Visit to RMNH, Mysore, to study models of freshwater, marine, estuarine and terrestrial habitats.
14. Survey of Animal Population - to visit different habitats/areas in and around Mysore and collect data on some population attributes, application of Bio-statistical tests to the collected data and its interpretation.
15. Visit to nearby Zoological garden, wildlife sanctuaries, Animal rehabilitation centres.

REFERENCES

1. Begon, Harper and Townsend, 1995. Ecology: Individuals, populations and community. II edition. Blackwell Series, U.S.A.
2. Bhatia, H.S. 1998: A Text book on Environmental Pollution and Control, Galgotia, New Delhi.
3. Clarke, G.L. 1963. Elements of Ecology, . Wiley Eastern Limited. New Delhi.
4. Emmel, T.C. 1976. Population Biology, Harper and Row publishers, N.Y.
5. Kormondy, E.J. 1978. Concepts of Ecology, Prentice Hall of India Pvt. Ltd., New Delhi.
6. Odum E.P. 1971. Fundamentals of Ecology. III Edition. W.B.Saunders's Co., Philadelphia.
7. Odum, E.P. 1983. Basic Ecology, Holt Saunders, Japan.
8. Sharma, P.D. 1996: Ecology and Environment Rastogi, Publications, Meerut.
9. APHA, 1992: Standard methods for examination of water and waste water, 18th edition
10. Negi, S.S and Bahuguna, V.K. 1983. An Introduction to wildlife management. Bishen Singh Mahendra Pal Singh. Dehara Dun, India.
11. NBA. 2004. The Biological Diversity Act (2002) and Biological Diversity rules (2004). National Biodiversity Authority, India.
12. Saharia, V.B. 1982. Wildlife in India. Natraj Publishers. Dehara Dun.

**M.Sc., III SEMESTER
SC 3.4 ETHOLOGY**

UNIT - I	48 Hrs
A. Descriptive versus experimental approaches	8 Hrs
B. Reflexes and complex behaviour- Latency, after discharge, summation, warm up, fatigue inhibition and feedback control	
C. Instinctive Behaviour - Fixed action pattern, Types of sign stimuli and releasers as triggers, Genetic basis of instinctive behaviour.	
UNIT- II	8 Hrs
A. Development and behaviour- Causes of behavioral changes during development, development of bird song.	
B. Learning- Classical conditioning experiment, latent and insight learning. Social learning, learning sets and play.	
C. Importance of early experience – Critical period- Filial imprinting, Sexual imprinting in birds, Imprinting like process in mammals.	
UNIT- III Foraging and anti-predator behaviour	8 Hrs
i. Anti predator behaviour – avoiding detection through colour and Markings (Mullarian mimicry)	
ii. Warning coloration	
iii. Batesian mimicry	
UNIT-IV Biological communication	8 Hrs
i. Forms of signals,	
ii. Visual communication with suitable examples,	
iii. Auditory Communication	
iv. Tactile and Chemical communication	
UNIT -V Sexual Behaviour	8 Hrs
i. Hormones and sexual behaviour – Selected examples of courtship and mating behaviour.	
ii. Pheromones in Insects and Mammals	
iii. Lee Boot, Whitten, Bruce, Collidge and Castro-Vandenberg effect/s	
iv. Selected examples of courtship and mating behaviour	
UNIT-VI Social Behaviour	8 Hrs
i. Introduction	
ii. Advantages of grouping	
iii. Social organization in insects with special reference to ants and honeybees	
iv. Social organization in sub human primates	
v. Altruism, Kin selection and Genetic control of behaviour	
TUTORIALS – On the basis of the proposed chapters.	2x16 = 32 Hrs.
REFERENCES	
1) Goodenough J.E., Mc Guire B. and Wallace R. A. (1993) Perspectives on Animal Behaviour. John Wiley and sons, New York.	
2) Tinbergen (2006) Social ehaviour in Animals. J.V. Publishing House Jodhpur India.	
3) Vandenberg. J.E.(Ed) (1983). Pheromones and Reproduction in mammals. Academic Press. NewYork.	
4) Agrawal, K.C. 2000. Biodiversity. Agrobios. India.	

M.Sc., III SEMESTER
SC – 3.5 POLLUTION AND TOXICOLOGY

48hrs

Part A - Pollution

24 hrs

Unit I:

8 hrs

A. Concept of Biosphere: Its components, hydrosphere, atmosphere, and lithosphere, Origin of life in the biosphere.

B. Water pollution: Definition, sources Types and classification of pollutants. Effects of Water Pollution, River Pollution, Oxygen sag curves and Eutrophication Drinking water: Collection, purification and distribution. Wastewater treatment: Primary, secondary and tertiary treatment.

Unit II:

8 hrs

A. Atmospheric pollution: Primary and secondary air pollutants. Biological effects of Nox, SO_x, SPM, Hydrocarbons, Acid rain, Global warming, Photochemical smog and Ozone hole.

B. Solid waste and Biomedical waste: Sources, collection, transport, treatment and Disposal methods.. Noise Pollution: Sources, Biological effects, Control measures and OSHA standards.

Unit III:

8hrs

A. Radiation & Thermal pollution: Sources, types, effects, Atmospheric fallout and abatement.

B. Environmental Impact Assessment: Basic elements, Methods Guideline for industrial EIA, Aquaculture related EIA, Transport related EIA and Water related EIA. Case studies: Konkan Railway, Silent valley, Bhopal Tragedy and Love canal tragedy, Mangalore Bojpe tragedy

Part B – Toxicology

24 hrs

Unit IV:

8hrs

A. General Principles of Toxicology: Introduction, Definition of toxicology Importance of Dose and Dose-response, factors influencing toxicity, Bioassay-toxicity evaluation studies using fish as model.

B. Toxic compounds: Heavy metals-Lead and mercury, Hydrocarbons- Aromatic and Aliphatic, and cyanides, and toxic gases - Bhopal tragedy.

Unit V:

8hrs

A. Biotransformation: Bioactivation, Biodetoxification of organo phosphates and organo chorines in the bodies of animals.

B. Natural toxins, Venoms and poisons: Properties and their effects, Major Sites and mechanism of action, Toxins in lower and higher organisms, Toxin and Venom therapy.

Unit VI:

8hrs

A. Smoking aids: Active and Passive smoking, Consumption of tobacco, Mariguana(Ganja), their effects and Prevention measures.

B. Cosmetics: Types of cosmetics, Chemical Characteristics, Applications, Exposure and risk assessment, Cosmetic safety regulations.

C. Risk assessment: Exposure assessment, Dose-Dosage, Risk characterization, Risk analysis and communications, Occupational health and illness.

TUTORIALS – On the basis of the proposed chapters

2x16 = 32 Hrs

REFERENCES:

1. Nandini, .N. Sunitha N. and T. Sucharita 2010. Environmental Studies, Sapna Book House Bangalore
2. Frant C.L.V. 1991, Basic Toxicology II (Eds.), Hemisphere publishing corporation, Washington, London
3. Sambasiva Rao K.R.S. 1999. Pesticide impact on fish metabolism. (Eds.) Discovery Publishing House, New Delhi.
4. Bio-pesticides in Insect Pest Management 1999. S. Ignacimuthu and Alok Sen, Phoenix Publishing House Pvt., Ltd., New Delhi.
5. APHA, AWWA and WEF. 1992: Standard Methods for Examination of Water and Wastewater, XVIII Ed, American Public Health Association. NY, USA
6. Nebel, B.T. and Wrigly R.T. 1998. Environmental Science, VI Ed. Prentice Hall New Jersey, USA
7. Hosetti, B.B. 2001. A Text Book of Applied Aquatic Biology, Daya Publishing House, Delhi.
8. Hassall, K.A. 1990. The Biochemistry and uses Pesticides structure, metabolism and Mode of action and uses in crop protection, John Wiley & Sons. Inc.
9. Pandey, K. and J.P. Shukla, 1990. Elements of Toxicology. Radha publ. New Delhi.

**M.Sc., III Semester:
OPEN ELECTIVE-(For Science discipline students).
CONCEPTS OF ZOOLOGY.**

48 Hrs

1. Introduction:

8 Hrs

a) Branches of animal science: Taxonomy, Animal Physiology, Genetics, Developmental Biology, Evolution, Ethology, Ecology, Applied Zoology, Entomology, Histology, c) Indian Wildlife- Status, Causes of wildlife depletion, Wildlife corridors, Conservation strategies- *In situ* and *Ex situ* d) e) Animals and human welfare.

2. Animal Taxonomy:

4 Hrs

a) Carl Linnaeus – Taxonomic hierarchy: Kingdom, Division, Phylum, Class, Order, Family and Binomial nomenclature

3. Animal cells and Tissues :

8 Hrs

a) Brief description of animal cell (light and ultra structure) b) Functions of cell organelles c) Structure and functional diversity in animal cell d) Cell division: Types and significance e) Structure and functions of basic tissues.

5. Structure and functions of organ systems:

16 Hrs

a) Human alimentary canal and outlines of digestion and absorption
b) Respiration: Human respiration – exchange of gases.
c) Circulation : Structure of human heart, Blood vessels and capillaries, composition of blood, blood coagulation.
d) Excretion : Mammalian kidney and urine formation.
e) Locomotion in vertebrates – Swimming, walking running, flying
f) Nervous system and their functions, A brief account of human endocrine system
g) Reproduction : Asexual and sexual reproduction, significance of sexual reproduction, outlines of human reproduction and fertility control

6. Ecology and Environmental Biology:

8 Hrs

a) Abiotic and Biotic factors b) Environmental Pollution – brief account of Air, Water and Noise pollution.

7. Heredity:

4 Hrs

a) Continuity of life – Mendel's laws b) Structure of chromosomes c) DNA and RNA

TUTORIALS

2x16=32 Hrs

REFERENCES :

1. Barnes, R. D. 1974. Invertebrate Zoology, III edition, W. B. Saunders Co., Philadelphia.
2. Barrington, E. J. W. 1976. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London
3. Hyman L. H. 1940. The invertebrates Vol.1 Protozoa through Ctenophora, McGraw hill co., N. Y.
4. Hyman. L. H. 1968. The Invertebrates Vol.8 McGraw Hill Co., N. Y and London.
5. Parker, T. J. Haswell, W. A. 1961. Text book of Zoology, Vol.I, Macmillon Co., London.
6. Russel – Hunter, W.D 1969. A. biology of higher invertebrates, Mac millon Co., Ltd., London.
7. Barrington, E. J. W. 1965. The Biology of Hemichordata and Protochordata – Oliver and Boyd, Edinburgh.

11. Clark, W. E 1963. History of the Primates IV Edn., Univ. of Chicago Press, Chicago.
12. Malcom Jollie, 1962. Chordata morphology – East-West Press Pvt. Ltd., New Delhi.
13. Romer, A. S. 1966. Vertebrate Paleontology, 3rd Ed., Univ. of Chicago Press, Chicago.
14. Romer A. S., 1960. Vertebrate body, 3rd Ed., W. B. Saunders Co., Philadelphia.
15. Young. J. Z., 1950. Life of vertebrates The Oxford University Press, London
16. Young J Z 1957 Life of mammals, Oxford University Press, London.

M.Sc., IV SEMESTER
HC – 4.1 ADVANCED GENETICS AND COMPUTATIONAL BIOLOGY

32 hrs

Part A-Advanced Genetics

Unit I: Genome organization: **3 hrs**

Prokaryotes, Eukaryotic nuclear genomes - C-value paradox, Eukaryotic organelle genomes
Split Genes Mobile genetic elements in Prokaryotes (bacteria) and Eukaryotes (*Drosophila*,
maize and humans), Genome Projects of model organisms (*C. elegans*, *Drosophila* and
Mouse).

Unit II: Cancer Genetics: **5 hrs**

Cancer incidence and mortality, types of cancer, causes of cancer, properties of cancer cells,
Genetic basis of Carcinogenesis- Oncogenes: proto-oncogenes, oncogenes, retroviral
oncogenes in human cancer. Tumor suppressor genes: Functions of tumor suppressor gene
products. Cancer as a multistep process. Animal models of cancer research: Transgenic
mouse and *Drosophila* models.

Unit III: Human genetics: **5 hrs**

History of human genetics, pattern of inheritance, pedigree analysis. Human genome:
Organization, distribution of genes, gene families. Genetic basis of syndromes and disorders:
Cystic fibrosis, Neurofibromatosis, Schizophrenia, Anxiety disorder, Congenital heart
diseases, Dyslexia.

Unit IV: Quantitative genetics: **3hrs**

Introduction, types of quantitative trait, Nature of quantitative traits and
their inheritance- Polygenic inheritance (Multifactorial hypothesis) –
analysis of continuous variation; Variations associated with polygenic traits.

Part B-Computational Biology

Unit VII: Introduction and Scope of the Computational Biology **4 hrs**

Genomics: Definition and types of genomics Structural genomics: whole genome shotgun
sequencing, gene annotation, gene families and clusters. Orthologs and paralogs. Functional
genomics: Transcriptome, Microarray technology.

Unit VIII: Proteomics: **4 hrs**

Definition, Protein structure determination, protein domains, protein folding, Computer
aided protein structure analysis, Protein-protein interactions, Protein microarrays.

Unit IX: Nucleic acid sequence and Protein analysis: **4 hrs**

Alignment, similarity searches including remote similarity searches, secondary structure
element, motifs, Single nucleotide polymorphism(SNP), Two dimensional polyacrylamide
gel electrophoresis, Mass Spectrometry.

Unit X: Genomics and proteomics databases and tools: **4 hrs**

Nucleic acid sequence databases and tools: Genbank, UCSC, ENSEMBL, EMBL, DDBJ,
BLAST vs FASTA, file formats-FASTA, GCG, Genscan and ClustalW. Protein sequence
databases and tools: Uni- prot, PDB, PIR, BLAST, PSI- BLAST (steps involved in use and
interpretation of results).

PRACTICALS:

1. Study of mitotic chromosomes of *Drosophila* species- *Drosophila melanogaster*, *Drosophila nasuta*.
2. Preparation of metaphase chromosomes from bone marrow cells of mouse.
3. Karyotypic studies of normal human chromosomes and syndromes.
4. Creation of pedigrees and study of patterns of inheritance.
5. Studies on phenotypes of different diseases and syndromes.
6. Study of Quantitative characters: Sternopleurals, Acrosticals – mean, standard deviation.
7. Data mining for sequence analysis.
8. Web– based tools for sequence searches and homology screening-BLAST, FASTA
9. Nucleic acid sequence databases: GenBank retrieval, GeneScan.
10. Proteomics data bases: Uni-Prot, PROSITE, PDB, PIR, ProtParam.
11. Annotations: ORF finder, Use of ARTEMIS or any other suitable software

REFERENCES:

1. The Human Genome 2001, Nature Vol. 409.
2. The *Drosophila* Genome. 2000, Science Vol. 267.
3. The *Caenorhabditis elegans* genome 1998. Science Vol. 282.
4. Introduction to Genetic Analysis. Griffiths, Anthony J.F.; Miller, Jeffrey H.; Suzuki, David T.; Lewontin, Richard C.; Gelbart, William M. New York: W.H. Freeman & Co.; 1999
5. Fundamental Neuroscience. Larry R. Squire, Darwin Berg, Floyd Bloom, and Sascha du Lac. Third Edition, Academic Press; 3 edition (2008)
6. Principles of Neural Science. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. McGraw-Hill Medical; 4 edition(2000)
7. Neurogenetics: Scientific and Clinical Advances (Neurological Disease and Therapy) David R. Lynch, Informa HealthCare; 1 edition (2005)
8. The Molecular and Genetic Basis of Neurologic and Psychiatric Disease. Roger N Rosenberg, Salvatore DiMauro, Henry L Paulson, and Louis Pt (2007) Lippincott Williams & Wilkins; Fourth edition
9. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA
10. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
11. A.Malcolm Campbell and Laurie J.Heyer. Discovering Genomics, Proteomics and Bioinformatics. 2004. Low Price edition. Pearson Education, Inc.

M.Sc., IV SEMESTER
HC – 4.2 APPLIED ZOOLOGY

32 hrs

UNIT I: Aquaculture

8hrs

Aquaculture in India: an overview – nutritional value and food security - Site selection and preparation of culture ponds - Fish culture: carps, marine fishes and ornamental fishes. Prawn culture: Freshwater prawns and marine shrimps. Fattening of crabs. Crayfish and Lobster - Molluscs: mussels, clams, chanks and oysters including pearl oyster. Live feeds: micro algae, micro-invertebrates (*Artemia* nauplii, Rotifers, Cladocerans, Copepods, Ostracodes) and worms as live baits – Water quality management and maintenance of sanitation - Plant and animal nutrients - Balanced diet (iso-nitrous and iso-caloric) - Artificial feed formulation – Low cost feed formulation - Aquatic weeds.

UNIT II: Sericulture

8hrs

Salient features of Saturniidae and Bombycidae. Mulberry and non mulberry silkworms, classification based on voltinism, moulting and geographic origin. Morphology and life cycle of *Bombyx mori*. Structure and functions of Silk glands. Silkworm rearing technology: Building, equipments, disinfection, environmental factors, Seed cocoons, preservation, grainage activity, LSPs, egg production, incubation, artificial hatching. **Pests and diseases:** Protozoan, Fungal, Viral and Bacterial diseases and their control measures. Silkworm pests and Predators

UNIT III: Apiculture

8hrs

Scope and its importance, Classification and morphology of honey bees, species and races of honey bees, tribal life and bee hunting. sex separation, comb building, orientation of comb, communication, collection of propolis and water. Honey and its chemical composition, medicinal importance. Economic importance of honey, wax, bee pollination, pollen and Venom.

UNIT IV: Vermiculture

8hrs

A. Introduction to vermiculture. Definition, meaning, history, economic importance, their value in maintenance of soil structure. Useful species : Local species and Exotic species of earthworms. Role of four R's.
B. Taxonomy Anatomy, Physiology and Reproduction of Lumbricidae and Eudrilidae.
C. Earthworm Farming (Vermiculture) for home gardens, larger scale, Extraction (harvest), vermicomposting harvest and processing.
D. Nutritional Composition of Vermicompost for plants, comparison with other fertilizers
E. Enemies of Earthworms, Sickness

PRACTICALS:

16X4=64 hrs

1. Study of morphometric characters of Indian major carps.
2. Diversity of fishes.
3. Collection of phytoplankton and zooplankton from natural resources and their identification.
4. Study of morphology of honey bee and cast system.
5. Mounting of mouth parts, stinging apparatus of honey bee.
6. Study of digestive system of honeybee.
7. Study of structure and types of honey comb.
8. Study of bee plants.
9. Study of morphology of lifecycle of *Bombyx mori*
10. Study of digestive and silk gland of *Bombyx mori*

11. Study of Non mulberry silkworms and their food plants.
12. Field trip- Collection of native earthworms & their identification
13. Study of systematic position& External characters of locally available earthworm species.
14. Mounting of setae and identification of earthworm species.
15. Study of equipments used in Vermiculture.

REFERENCES

1. Ashok Kumar (2009) Textbook of Animal Diseases
2. Edwards, C.A. and J.R. Lofty (1977) "Biology of Earthworms" Chapman and Hall Ltd., London.
3. G.S. Shukla, V.B. Upadhyay (2006) Economic Zoology.
4. Kevin, A and K.E.Lee (1989) " Earthworm for Gardeners and Fisherman" (CSIRO, Australia, Division of Soils)
5. Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use" Academic Press, Sydney.
6. Pradip. V Jabde, (2005) Text Book of Applied Zoology.
7. R. L. Kotpal (2000) Modern Textbook of Zoology. Rastogi Publications
8. Satchel, J.E. (1983) "Earthworm Ecology" Chapman Hall, London.
9. Wallwork, J.A. (1983) "Earthworm Biology" Edward Arnold (Publishers) Ltd. London.

**M.Sc., IV SEMESTER
HC – 4.3 Project**

M.Sc., Examination
(Scheme CBCS)
M.Sc., ZOOLOGY
HARD CORE- Model question paper

Time: 3 hrs

Max Marks: 70

Instructions: *1. Answer all questions*
2. Illustrate your answer wherever necessary

I. Write short notes on the following:

[8×2=16]

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

II. Write elaborate notes on any FIVE of the following:

[5×6=30]

- 9.
- 10.
- 11.
- 12.
- 13.
- 14.
- 15.
- 16.

Q3. Answer the following:

[2×12=24]

17. (i)
Or
(ii)
18. (i)
Or
(ii)

M.Sc Examination
(Scheme CBCS)
M.Sc., ZOOLOGY
Softcore - Model question paper

Time: 3 hrs

Max Marks: 70

Instructions: *1. Answer all questions*
2. Illustrate your answer wherever necessary

I. Write short notes on the following:

[8×2=16]

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

II. Write elaborate notes on any FIVE of the following:

[5×6=30]

- 9.
- 10.
- 11.
- 12.
- 13.
- 14.
- 15.
- 16.

Q3. Answer the following:

[2×12=24]

17. (i)
Or
(ii)
18. (i)
Or
(ii)

M.Sc Examination
(Scheme CBCS)
M.Sc., ZOOLOGY
Open Elective-Model question paper

Time: 3 hrs

Max Marks: 70

Instructions: *1. Answer all questions*
2. Illustrate your answer wherever necessary

I. Write short notes on the following:

[8×2=16]

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

II. Write elaborate notes on any FIVE of the following:

[5×6=30]

- 9.
- 10.
- 11.
- 12.
- 13.
- 14.
- 15.
- 16.

Q3. Answer the following:

[2×12=24]

17. (i)
Or
(ii)
18. (i)
Or
(ii)