



BANGALORE UNIVERSITY

M.Sc. ZOOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) SYLLABUS

I – IV SEMESTER

BANGALORE UNIVERSITY
DEPARTMENT OF ZOOLOGY

2014-15

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CHOICE BASED CREDIT SYSTEM

COURSE CONTENTS FOR M.Sc. ZOOLOGY

	I SEMESTER	T Hr	P Hr	TOTAL CREDITS
HC 101	BIOLOGY OF NON-CHORDATES	4	4	6
HC 102	BIOLOGICAL CHEMISTRY	4	4	6
HC 103	GENERAL PHYSIOLOGY	4	4	6
HC 104	GENETICS AND CYTOGENETICS	4	4	6
SC 105	BIOLOGICAL DIVERSITY AND ANIMAL BEHAVIOR	3	0	2
		19	16	26
	II SEMESTER			
HC 201	BIOLOGY OF CHORDATES	4	4	6
HC 202	APPLIED ENTOMOLOGY	4	4	6
HC 203	AQUATIC BIOLOGY AND FISHERIES	4	4	6
HC 204	HISTOLOGY & HISTOCHEMISTRY	4	4	6
SC 205	BIostatISTICS AND COMPUTER APPLICATIONS	3	0	2
		19	16	26
	III SEMESTER			
HC 301	BIOLOGY OF REPRODUCTION	4	4	6
HC 302	POPULATION GENETICS & EVOLUTIONARY BIOLOGY	4	4	6
HC 303	ECOLOGY & ENVIRONMENTAL BIOLOGY	4	8	8
OE 305	ECONOMIC ZOOLOGY	4	0	4
		16	16	24
	IV SEMESTER*			
HC 401	GENERAL ENDOCRINOLOGY	4	2*	5
HC 402	CELL AND MOLECULAR BIOLOGY	4	2*	5
HC 403	APPLIED PHYSIOLOGY	4	2*	5
HC 404	DEVELOPMENTAL BIOLOGY	4	2*	5
PR 405	PROJECT	0	8	4
		16	16	24
	TOTAL	70	64	100

HC- Hard Core = 15 Papers; SC-Soft Core = 02 Papers; OE- Open Elective = 01 Paper;
PR-Project = 01 Paper

*2hr practicals of one credit for 25 marks (IA 7 + P 18) instead of 2x4hr or 1x8hr practicals.

- Where field visit is involved, 10marks will be for one

- Theory test and 10marks will be for field visits.

HC 101: BIOLOGY OF NON-CHORDATES

52hr

13hr

Unit 1:

- a) **Non-chordata** - classification with diagnostic features up to class level.
- b) **Origin of metazoa**
- c) **Origin and Organization of Coelom:** Acoelomates, pseudo coelomates and coelomates

Unit 2:

13hr

- a) **Locomotion:** Amoeboid, Flagellar and Ciliary movement in protozoa. Hydrostatic movements in Coelenterata. Mollusca and Echinodermata
- b) **Nutrition and Digestion:** Patterns of Feeding and digestion in lower Metazoa, Mollusca, Echinodermata, Filter feeding in polychaeta, Mollusca and Echinodermata

Unit 3:

13hr

- a) **Respiration and Excretion:** Organs of respiration : Gills, lungs and trachea. Respiratory pigments. Mechanism of respiration. Excretion in lower invertebrates. Excretion in higher invertebrates. Mechanism of Osmoregulation.
- b) **Nervous System:** Primitive Nervous systems:-Coelenterata and Echinodermata. Advanced nervous system - Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda). Sense organs and their importance

Unit 4:

13hr

- a) **Invertebrate larvae:** Invertebrate larval forms and their evolutionary significance. Trematoda and Cestoda. Larval forms of Crustacea, Mollusca and Echinodermata.
- b) **Minor Phyla:** Structure affinities and life history of the following minor Phyla-Rotifera, Entoprocta, Phoronida and Ectoprocta

Bibliography

1. Hyman, L.H. The invertebrates, Vol. I. protozoa through Ctenophora, McGraw Hill Co., New York
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson & Sons Ltd., London.
3. Hyman, L.H. The Invertebrates. Vol. 2. McGraw Hill Co., New York.
4. Hyman, L.H. The Invertebrates. Vol. 8. McGraw Hill Co., New York and London.
5. Barnes, R.D. Invertebrates Zoology, III edition. W.B. Saunders Co. Philadelphia.
6. Russel-Hunter, W.D. A biology of higher invertebrates, the Macmillan Co. Ltd., London.
7. Read, C.P. Animal Parasitism. Parasitism prentice Hall Inc., New Jersey.
8. Sedgwick, A.A. Student text book of Zoology. Vol. I,II & III. Central Book Depot, Allahabad.
9. Parker, T.J., Haswell W.A. Text book of Zoology, Macmillan Co., London.

PRACTICALS:

52hr

1. **Protozoa:** *Trypanosoma*, *Plasmodium*, *Radiolaria*, *Balantidium*, *Monocystis*, *Noctiluca*, *Paramecium*
2. **Porifera:** *Leucosolenia*, *Euplectella* (Venus flower basket), *Hyalonema*
3. **Cnidaria:** *Hydra*, *Carrybdea* (Cubozoan medusa), *Tubipora*, Alcyonarian coral, *Physalia* (Portuguese man of war), *Pennaria*, *Velella*, *Porpita*, *Aurelia*, *Obelia*, Sea Anemone
4. **Platyhelminthes & Nemathelminthes:** *Microstomum*, *Gyrodactylus*, *Schistosoma haematobium* (Blood worm), *Echinococcus granulosus* (Dog tapeworm), *Ancylostoma duodenale* (Hook worm), *Trichinella spiralis* (Pin worm)
5. Annelida: *Nereis*, *Aphrodite*, *Tubifex*, *Placobdella*, *Hirudinaria* (Leech), *Arenicola*, *Sabella*, Earthworm, *Chaetopterus*
6. **Arthropoda:** Black widow spider, *Cyclops*, *Calanus*, *Lepas*, *Balanus* (Acorn barnacle), Centipede, Millipede, *Xiphosura limulus* (King crab)
7. **Mollusca:** *Neopalina*, *Cardium*, *Sepia*, *Loligo*, *Patella*, *Chiton*, *Dentalium*, *Murex xanchus*
8. **Echinodermata:** *Ophiothrix*, Sea urchin, Heart urchin, Starfish, Sea cucumber, Echinoderm larvae
9. **Dissections: Cockroach** (Lab bred): 1) Reproductive system of male & female 2) Nervous system.

HC 102: BIOLOGICAL CHEMISTRY

52hr

Unit 1: pH and Buffers:

13 hr

- a) Properties of water, law of mass of action, pH, dissociation of water and its ion product
- b) Dissociation of strong electrolytes, ionization of weak bases, Henderson-Hasselbalch equation, titration curves, determination of pK_a
- c) Buffers- formulation and significance of buffers, biological buffers.

Unit 2: Biomolecules and Metabolism:

13 hr

- a) Carbohydrates: Classification, properties and significance. Derived sugars Metabolism of carbohydrates: Glycolysis, TCA cycle, HMP shunt and their energetic pathways. Glyoxylate cycle, uronic acid pathway. mitochondrial ATP synthesis. Glycogen metabolism - Gluconeogenesis, glycogenesis, glycolysis and regulation of glycogen metabolism.
- b) Lipids: Classification, properties and significance, phospholipids, sphingolipids, glycolipids, steroids & prostaglandins. Oxidation of fatty acids & energetic, ketogenesis & its implications
- c) Proteins: Amino acids - Classification, properties and significance. Transamination, deamination and decarboxylation. Proteins- Classification, structure, properties and significance

Unit 3: Enzyme:

13 hr

- a) Enzyme kinetics and properties of enzyme-catalyzed reactions. Substrate concentration, specificity, enzyme concentrations, temperature, pH and inhibitors. Significance of inhibitors. Michaelis-Menten equation. Lineweaver-Burk plot.
- b) Mechanisms of enzyme catalysis- Oligomeric enzymes-isoenzymes, allosteric enzymes and multienzyme complexes. Coenzymes-structure and function of water-soluble coenzymes, minor coenzymes and their functions

Unit 4: Biochemical Energetics:

13 hr

- a) Exergonic and endergonic reactions, concept of free energy and energy-rich compounds- pyrophosphate compounds, and other energy-rich compounds
- b) Electron transport chain, oxidative phosphorylation and substrate level phosphorylation.

Bibliography

1. Harper HA. Review of Physiological Chemistry (Lange Publications) 1993
2. Lehninger AL, Nelson DL and Cox MM. Principles of Biochemistry (CBC Publishers) 1993
3. Rastogi SC. Biochemistry (Tata Mc GrawHill Publishing Co. Ltd.) 2003
4. Satyanarayana U. Biochemistry (Book Syndicate Pvt. Ltd) 2006
5. Stryer. Biochemistry (WH Freeman and Co. Pub.) 2008
6. Plummer DT. Practical Biochemistry (Tata Mc GrawHill Publishing Co. Ltd.) 1993
7. Varley H. Practical Clinical Biochemistry (CBS Publications) 1980

PRACTICALS:

52hr

1. Quantitative analysis of milk
2. Estimation of total amino acids
3. Determination of urine creatinine content
4. Determination of DNA and RNA content
5. Estimation of total proteins
6. Preparation of standard graphs for proteins and cholesterol
7. Determination of molecular weight of carboxyl amino acid
8. Study of enzyme kinetics-
 - a) effect of substrate concentration
 - b) effect of temperature
 - c) effect of pH on enzyme activity
9. Analysis of dipeptides for amino acids

HC 103: GENERAL PHYSIOLOGY

52hr

Unit 1: Cellular Physiology:

13hr

- a) **Biological membranes:** Movement of molecules across cell membranes, Osmosis, Body fluids. Oligomeric membrane ionophores and membrane proteins in invertebrate and vertebrates models, LDL as a model recognition site.
- b) **Homeostasis:** Positive and negative feedback, General patterns of acclimation, Precht and Prossers pattern of temperature tolerance, Temperature regulation in animals living in high and low temperatures, Role of brown fat in temperature regulation.
- c) **Osmoregulation:** Concepts of osmoregulation, Osmoregulation in animals of aquatic and terrestrial environments. Excretory patterns and osmoregulation. Role of renal and extra renal tissues in osmoregulation.

Unit 2: System Physiology:

13hr

- a) Blood and body Fluids: Blood and its components, Heart cycle, Electrical Properties of the heart, ECG, Control of cardiac output. Vascular system, Regulation of arterial blood pressure.
- b) Respiration: Gas exchange and mechanism of respiration in invertebrates and vertebrates oxygen curves and control of respiration.
- c) Gastrointestinal system: Motility, secretion and absorption of nutrients, carbohydrate, protein and fat digestion. Role of dietary fiber in digestion. Nutritional disorders. Ruminant and non-ruminant digestive patterns, Endoparasitism.

Unit 3: Physiology of high altitude:

13hr

- a) Effects of acute exposure to high altitude, to Respiratory changes, Physiological polycythemia, Exercise at high altitude
- b) Stress physiology–basic concept of stress & strain, strain resistance, stress avoidance and tolerance
- c) Neuroendocrine & physiological responses to stress in animals. Hormesis, relevance of stress specificity

Unit 4: Exercise Physiology:

13hr

- a) Physiology of Exercise, Circulatory changes in muscular exercise, Blood pressure during exercise, Respiratory responses to exercise.
- b) Types of exercise, Response of muscle to exercise Endocrine response to exercise. Fatigue- induced biochemical and physiological changes.
- c) Role of Meditation, Yoga and their effects.

Bibliography

1. Eckert, Marsall, Animal Physiology Mechanism and Adaptations, 2002
2. Eckert & Randall, Animal Physiology (CBS), 2nd Ed, 2000.
3. Ganong. Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
4. Gordon M. Animal Physiology Macmillan & Co.; First edition (1972)
5. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), (W.B. Saunders), 2001
6. Hill R.W Comparative Physiology of Animals) Sinauer Associates) Third edition
7. Hoar W.S., General and Comparative Physiology(Prentice – Hall)1983
8. Houssay, Human Physiology, McGraw Hill Books Company, Second edition
9. Hutchinson, Hunter and Bomford, Hutchinson's Clinical Methods, (Lippincott)
10. Heil E and Joets N. Physiology,(Oxford University Press) 1982
11. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
12. Mill Peter J., Comparative Neurobiology (Ed. Harbord London)
13. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003
14. Philips JG., Environmental Physiology, (Blackwells)
15. Prosser C.L., Comparative Animal Physiology(WB Saunders Company)
16. Smith, Patterson, Text Book of Physiology (ELBS, Read & Scratched) 1988, 11th Ed.
17. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), (Williams and Wilkins) 1981.
18. Wilson J.A., Principles of Animal Physiology (McMillan, N.Y) 2nd edition

PRACTICALS:**52hr**

1. Study of blood pressure during rest and exercise
2. Visit to Yoga Centre / Demonstration by expert
3. Effect of exercise on breathing rate, pulse rate and blood lactate of man
4. Active transport of glucose through intestinal wall of vertebrates
5. Electrocardiogram and its interpretation
6. Measurement of ascorbic acid in blood and urine
7. Determination of excretory products in ammonotelic, ureotelic and uricotelic animals

HC 104: GENETICS AND CYTOGENETICS**52hr**

Unit I: Non mendelian genetics: a) Maternal effects – Pigmentation in *Limnea peregra* b) Organelle heredity – Mutations in Chlamydomonas, Mitochondria- *Petite in Saccharomyces* c) Infectious heredity – Kappa in Paramecium, Drosophila, d) Mitochondrial diseases in Man. **13hr**

Unit II

Gene and Genome expression: a) DNA as genetic material- Experiments of Griffith, Avery, Macleod & McCarty and Hershey Chase

Genome expression: (a) Mechanism of replication- Origin, Pattern, Elongation and Fidelity of replication (b) Mechanism of Transcription – Initiation, Elongation, Termination, Post transcriptional modifications (c) Mechanism of Translation – Translation process and factors, Initiation, Elongation, Termination and functions. **13hr**

Unit III

Regulation of gene expression in prokaryotes and eukaryotes: a) In Prokaryotes – Over view, Lac operon, Trp Operon, Trp operon b) In Eukaryotes – Over view, Regulation of transcription in eukaryotes – Eukaryotic promoters, transcription factors, enhancers, Post transcriptional regulation of gene. **13hr**

Unit IV

Human cytogenetics and Gene mutations: a) Human chromosome and karyotypes b) Autosomal and sex chromosomal anomalies c) Human genome project d) Prenatal diagnosis. **Gene Mutations:** a) Molecular mechanism of transition and transversion b) Missense, Non-sense, Neutral, Silent, Frameshift and Reverse mutations c) Gene mutations and diseases in man – Sickle cell anaemia, Thalassemia, Cystic fibrosis. **13hr**

Bibliography

1. Brookers RJ. 1999. Benjamin/ Cummings Genetic Analysis and Principles. Longman Inc.
2. Garner BP, Simmons EJ and Snustad MJ. 1991. Principles of Genetics. Jhon Willey and Sons. Inc. New York.
3. Griffiths AJG, Gilbert WM, Lewontin RC and Miller JH. 2003. Modern Genetic Analysis: Integrating Genes and Genomes. 2nd Ed. W.H. Freeman Co. New York.
4. Lewin B. 2003. Genes VIII. Oxford Univ Press. Oxford.
5. Hartl DL and Jones EW. 1999. Essential Genetics 2nd Ed. Jones and Bartlett Publishers

PRACTICALS:**52hr**

- 1) Drosophila culture - media preparation, Life cycle and morphology.
- 2) Mounting of sex comb of *Drosophila melanogaster*.
- 3) Dissection and mounting of male genital plate of *Drosophila melanogaster*.
- 4) Study and identification of *Drosophila melanogaster* mutants
- 5) Preparation of Mitotic chromosomes of *Drosophila melanogaster*
- 6) Karyotyping of normal human chromosomes and syndromes.

SC 105: BIOLOGICAL DIVERSITY AND ANIMAL BEHAVIOUR

40hr

Unit 1: Biodiversity:

13hr

- a) Biodiversity and its origin, Global and local trends , Mega biodiversity countries, hot spots and heritage sites, types of diversity (alpha, beta and gamma diversities), levels of biodiversity (genetic, species, ecological diversities), value of biodiversity.
- b) **Threats to biodiversity:** Mass extinction, global climate change and its impact on biodiversity, ecosystem degradation and loss, habitat fragmentation, overexploitation, exotic and invasive species, deforestation and loss of biodiversity.

Unit 2: Conservation biology:

13hr

- a) History, guiding principles, conservation challenges and models of conservation biology. IUCN Red list categories and criteria, habitat management and establishment of wildlife corridors and protected areas, bio-indicators. Biosphere reserves, *in situ* and *ex situ* conservations (sanctuaries, national parks, zoological parks, botanical gardens, oceanarium). Wild life conservation (Global and Indian) projects – scope and success.
- b) **Biodiversity and wildlife policies:** Biodiversity conventions, biodiversity Act and Rules, Global, National and Regional conservation efforts and legal aspects, Indian wildlife (Protection) Act.

Unit 3: Animal behaviour:

14hr

- a) **Development of behaviour:** Significance of animal behaviour, influence of environment, hormones and genes. Cognition, neural control of behaviour, adaptiveness of behaviour.
- b) **Learning and memory:** Innate behaviour (orientation, kinesis, taxis, motivation, tropism, reflex and nest building), learned behaviour (sensitization and habituation, associative learning, imprinting, latent and insight learning, reasoning, instrumental conditioning, trial-and-error, discrimination, biased and language learning), neural mechanism of learning. Memory- nature, types and anatomy of memory, and memory storage.
- c) **Evolution and Genetics of behaviour:** Genes and behavioural evolution, Hamilton's rule, kin selection, altruism, cost and benefits of social life, sex and sexual selection, phylogeny of behaviour, genetic control of behaviour (single and multiple gene effect).
- d) **Social behaviour:** Types of social groups, advantages of grouping, origin and roots to sociality, social organization- insects (honey bees, termites) and primates. Cost and benefits of sociality, and evolution of eusocial behaviour.

Bibliography

1. Alcock J 2013 Animal Behavior: An Evolutionary Approach, 10th edition (Sinauer Associates, Inc.)
2. Bolhuis J J and L Giraldeau (eds) 2005 The behaviour of animals (Blackwell Pub.)
3. Breed and Moore 2011 Animal Behavior, 1st Edition (Academic Press)
4. Burnse D (ed.) 2001 Animal: the definitive visual guide to worlds' wildlife (Cambridge University Press)
5. Collen B, Pettorelli N, Baillie J E M and Durant S M (Eds) 2013 Biodiversity Monitoring and Conservation: Bridging the Gap Between Global Commitment and Local Action (Wiley-Blackwell)
6. Ellermann J R 1961 The Fauna of India (Manager of Publications: New Delhi)
7. Franklinm J 2010 Mapping Species Distributions: Spatial Inference and Prediction (Ecology, Biodiversity and Conservation (Cambridge University Press)
8. Gadakar R 1997 Survival strategies (Universities Press)
9. Gee E P 1964 The Wildlife of India (Collins: London)
10. Ghosh A K 2008 Biodiversity (The Energy and Resources Institute: Delhi)
11. Goodenough J, McGuire B & Jakob E 2009 Perspectives on Animal Behavior (John Wiley & Sons)

12. Groom M J, Meffe G K, Carroll C R 2006 Principles of conservation biology (Sinauer Associates, Inc.: Sunderland, Massachusetts, USA)
13. Hnidae R A 1966 Animal behaviour (2nd Ed.) (McGraw Hill Book, London)
14. Hunter M L 2002 Fundamentals of Conservation Biology (Blackwell Publishing: Sunderland, Massachusetts, USA)
15. Kappeler P (Ed) 2010 Animal Behaviour: Evolution and Mechanisms (Springer)
16. Korb J and Heitze J C (eds) 2008 Ecology of social behaviour (Springer)
17. Krebs J R and N B Davies 1984 Behavioural ecology – An evolutionary approach. 3rd edition (Blackwell Scientific Publications)
18. Krishnan M 1972 India's Wildlife (Bombay Natural History Society: India)
19. Leveque C and Mounolou J 2003 Biodiversity (John Wiley and Sons, Ltd.: West Sussex, England)
20. Lovejoy T E and Hannah L 2006 Climate change and biodiversity (The Energy and Resources Institute: Delhi)
21. Magurran A E and McGill B J 2011 Biological Diversity: Frontiers in Measurement and Assessment (Oxford University Press: USA)
22. Mandal F B 2010 Textbook of Animal Behaviour (PHI Learning Pvt. Ltd.: New Delhi)
23. Mani M S 1974 Ecology and Biogeography of India (Junk Publ.: The Hague)
24. Manning A and Dawkins M S 1997 An Introduction to Animal behaviour (4th edition)
25. Mathur R 2008 Animal behaviour (Rastogi Pub.: India)
26. Menon V 2003 A field guide to Indian mammals (Dorling Kindersley Pvt. Ltd.: India)
27. Nair S C 1991 Southern Western Ghats: A biodiversity conservation plan (Indraprastha Press: New Delhi)
28. Nair S M 1992 Endangered animals of India and their conservation (National Book Trust: Delhi)
29. Prater S H 1971 The Book of Indian Animals (Bombay Natural History Society: India)
30. Primack R B 2010 Essentials of Conservation Biology (Bostan University: Sunderland, Massachusetts, USA)
31. Sagreiya K P 1967 Forests and Forestry (National Book Trust: India)
32. Shah J H, 1975 Introduction to Wildlife Management (McGraw Hill :New York)
33. Sherman P W and Alcock J 1997 Exploring animal behaviour (Sinauer Asso. Inc. Pub.: Sunderland, Massachusetts)
34. Slater P J B 1999 Essentials of Animal Behaviour (Cambridge Uni. Press)
35. Stracey P D 1963 Wildlife in India: Conservation & Control (Ministry of Agriculture, Govt. of India)
36. Thorpe W H 1963 Learning and instinct in animals (Methuen and Co. Ltd.: London)
37. Tikade B K 1983 Threatened animals of India (Zoological Survey of India: India)
38. Usher M B 1986 Wildlife Conservation and Evaluation (Chapman and Hall Ltd.: London)
39. Wilson E O 1992 The diversity of life. (Belladone press: Cambridge)
40. Zachos F E and Habel J C (Eds) 2011 Biodiversity Hotspots: Distribution and Protection of Conservation Priority Areas (Springer).

HC 201: BIOLOGY OF CHORDATES

52hr

Unit 1:

13hr

- Principles of taxonomy
- Nomenclature - Binomial, Trinomial nomenclature.
- Zoological Nomenclature –ICZN
- New trends in taxonomy
- Prochordate phylogeny - systematic position of Prochordates
- Origin of chordates

Unit 2:

13hr

- Ostracoderms:** Silurian and Devonian Ostracoderms. Evolutionary position of the Ostracoderms.
- Placoderms:** Origin of Jaws- Placoderms as ancient “experiment” in the evolution of the jawed vertebrates. Structural peculiarities of Cyclostomata.
- Chondrichthyes:** Fossil history of chondrichthyes, tendencies in Elasmobranch evolution.
- Actinopterygii:** Origin and evolution, Adaptive radiation of bony fishes.
- Amphibia:** Origin and evolution of Amphibia

Unit 3:

13hr

- Reptilia:** Evolution of Reptilia. Saurischian and Ornithischian Dinosaurs - Rhynchocephalia - Adaptive radiation of Reptiles.
- Aves:** Birds as glorified reptiles. Fossil history of birds. Palate in Birds. Adaptive radiation in birds.
- Mammal:** Evolution of Mammals, Structural peculiarities of Prototheria, Metatheria and Eutheria.

Unit 4: Comparative anatomy:

13hr

- Origin and evolution of the vertebrate integumentary system.
- Paired fins and limbs
- Heart and aortic arches
- Respiratory organs
- Urinogenital system
- Brain and Nervous system

Bibliography

- Waterman. A.J. 1971. Chordate Structure and Function. McMillan Co. London.
- Jolie, M. 1968. Chordate Morphology. East West Press. Pvt, Ltd,
- Romer, A.S. and Parson, T.S. 1978 Vertebrate Body. W.B. Saunders Co. Philaephia.
- Young, J.2.1969. Life of Vertebrates. Clarendon Press, Oxford.
- Colbert, E.H. 1969. Evolution of Vertebrates. John Wiley and Sons Inc, New York.
- Holstead. 1969 The Pattern of Vertebrate Evolution. Freeman and Co. San Francisco. U.S.A.
- Hobart M. Smith,1960Evolution of Chordate Structure,Holt,Rinehart&Winston Inc. New York
- Hyman L.H.1966 Comparative Vertebrate Anatomy. The University of ChicagoPress,Chicago

PRACTICALS:

52 hr

- Protochordata:** *Balanoglossus, Ascidia, Doliolum, Salpa, Oikopleura, Amphioxus.*
- Pisces:** *Carcharius (shark), Trygon, Clarias, Arius, Ostracion, Oreochromis, Channa, Hippocampus, Tetradon.*
- Amphibia: *Triton, Gegenophis, Amblystoma, Caccopus, Siren, Hyla, Ichthyophis.*
- Reptilia:** *Chamaeleon, Phrynosoma, Varanus,* King cobra, Krait, Turtle, Crocodile, Skulls of turtle and crocodile.
- Aves: **Skull and modifications in palate region – Desmognathous and Schizognathous type. eg. duck and pigeon.**
- Mammalia: *Loris, bat, squirrel, Platypus, porcupine, Pangolin,* skulls of dog, goat, cat, **rabbit, monkey and man.**
- Dissections: **Rat (Lab bred) : 1) Arterial and venous system 2) Neck nerves**

Unit 1: Principles of applied entomology and pest management: 13hr

- a) Insect origin and evolution, biodiversity, Insects of economic importance. **Pests** -Definition, categories, causes for outbreak, general equilibrium position, economic damage, economic injury level, economic threshold level, losses caused by pests.
- b) **Pest monitoring**- pest surveillance, forecasting, survey and sampling techniques, crop loss estimation.
- c) **Biological control**- History, concepts, classical examples, natural and biological control, predators, parasitoids, entomopathogenic microorganisms, entomophagous nematodes, biopesticides, exotic biocontrol agents, augmentative and conservation biocontrol, advantages and disadvantages of biological control.
- d) **Integrated pest management (IPM)**-Definition, concepts, goals and strategies of IPM, key components of IPM, IPM program development and models

Unit 2: Insect-plant interactions, chemical ecology and insect resistance: 13hr

- a) **Host plant-insect interactions**- Plant nutrition and secondary metabolites, host plant resistance mechanisms- ecological and genetic resistance, genetically modified resistant plants, sequestration and detoxification in insects.
- b) **Pheromones**- Types, chemical characteristics, pheromone olfaction mechanisms, biosynthesis of pheromones, pheromone application in pest management, pheromone traps and lures.
- c) **Insecticides**- Nomenclature, types (systemic insecticides, organochlorines, organophosphates, carbamates, pyrethroids, inorganics, botanicals, synergists, fumigants, insect growth regulators), formulations, toxicity parameters- LD₅₀, LC₅₀, LT₅₀, KD₅₀, ED₅₀/EC₅₀, mode of action, safety measures, advantages and disadvantages of pesticides.
- d) **Insect resistance**- History of resistance, cross and multiple resistance, resistance development, resistance mechanisms and management.

Unit 3: Productive insects and pests of economic importance: 13hr

- a) **Honey bees**-Honey bee species, role of bees in pollination, bee keeping and management practices, bee products, pests and diseases of honey bees and their management.
- b) **Silkworm**- Silkworm species, silkworm rearing and management practices, pests and diseases of silkworms/host plants and their management.
- c) **Household pests**-House fly, cockroaches, bed bugs, and ants –biology, economic importance and management. **Pests of stored products**- Rice weevil, Pulse beetle, and Rice moth –biology, damage and management.
- d) **Pests of crops**- Rice, vegetables, mango, coffee, coconut, cotton and sugarcane-biology, damage and management of major pests.

Unit 4: Medical entomology and parasitic diseases: 13hr

- a) **Vector biology and human parasites**- Malaria, filariasis and leishmaniasis-distribution and biology of vectors and parasites, host-parasite interactions and co-evolution, defense mechanisms, epidemiology and control.
- b) **Arboviral diseases**- Yellow fever, dengue, and Japanese encephalitis-epidemiology, vector biology and management.
- c) **Venomous insects and Forensic entomology** - Venomous insects and allergic reactions. Forensic entomology of human and wildlife.

Bibliography

1. Ananthakrishnan T N and Shivaramakrishnan K G 2008 Ecological entomology: Insect life in odd environment (Scientific Pub.: India)
2. Awasthi V B 2009 Introduction to general and applied entomology (Scientific Pub.: India)
3. Backer N 2003 Mosquitoes and their control (Springer)
4. Chapman R F 2004 The Insects: Structure and function (4th edn.) Cambridge University Press: Cambridge)
5. Cox F E G 1993 Modern Parasitology (Blackwell Scientific Publications: Oxford)
6. Crane E 1990 Bees and Beekeeping Science, Practice and World Resources. (Heinemann Newness: Oxford, UK)
7. David B V and Ananthakrishnan T N 2004 General and Applied Entomology. 2nd Edition (Tata McGraw-Hill Publ. Co. Ltd.: New Delhi)
8. Dent D R 1998 Insect pest management (Westville Publishing House: Delhi)
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11. Eldridge B 2004 Medical entomology (Springer)
12. Fenemore P G and Prakash A 2009 Applied Entomology (New Age Publishers: New Delhi)
13. Graham M J 1993 The hive and the honey Bee (Dadant and Sons, Hamilton: Illinois)
14. Gullan P J and Cranston P S 2010 The insects- An outline of entomology 4th Edition (Blackwell Science Ltd)
15. Gurr G M, Wratten S D and Snyder W E (Eds) 2012 Biodiversity and Insect Pests: Key Issues for Sustainable Management (Wiley-Blackwell)
16. Hill D S 1993 Agricultural insect pests of the tropics and their control (Cambridge University Press)
17. Hill D S 2008 Pests of crops in warmer climates and their control (Springer)
18. Howse P E, Stevens I D R and Jones O T 1998 Insect Pheromones and Their Use in Pest Management (Chapman & Hall: London)
19. Ishaya I, Palli S R and Horowitz A R (Eds) 2012, Advanced Technologies for Managing Insect Pests (Springer)
20. Jervis M A 2007 Insects as natural enemies (Springer)
21. Lehane M J 1991 Biology of Blood-sucking Insects (Harper Collins Academic: London)
22. Marquardt W C, Demaree R S and Grieve R B 2000 Parasitology and Vector Biology (Academic Press: USA)
23. Norris R F, Caswell-Chen E P and Kogan M 2003 Concepts in integrated pest management (Prentice-Hall Inc.: New Jersey)
24. Pedigo L.P 2004 Entomology and Pest Management 4th Edition. (Prentice- Hall Inc.:New Jersey)
25. Perry A S, Yamamoto I, Ishaaya I and Perry R 1998 Insecticides in Agriculture and Environment (Narosa Pub. House: New Delhi)
26. Resh and Cardé (Eds) 2009 Encyclopedia of Insects, 2nd Edition (Academic Press)
27. Schowalter T 2011 Insect Ecology: An Ecosystem Approach 3rd Edition (Academic Press)
28. Silver J B 2008 Mosquito ecology 3rd ed. (Springer)
29. Smyth J D 1994 Animal Parasitology (Cambridge University Press)
30. Tautz J 2008 The Buzz about bees 1st ed. (Springer)
31. Van Emden H F and Peakall D B 1996 Beyond Silent Spring: Integrated Pest Management and Chemical Safety (Chapman and Hall: London)
32. Winston M 1984 The Biology of the honeybee (Harvard Uni. Press: London, UK)

1. **Mounting:**
 - a) Dry mounting and slide mounting.
 - b) Sting apparatus, hypopharyngeal gland and pollen basket of honey bees.
2. **Productive insects:**
 - i. *Bombyx mori* (Mulberry) adults, cocoons, *Exorista sorbelensis* (Uzi fly parasite).
 - ii. *Apis cerana* (Hive bee) and *A. mellifera* (European bee) adults, pollen, bee wax, queen cell, *Galleria mellonella* (greater wax moth)
3. **House hold pests:** *Musca* spp. (House fly), *Cimex hemipterus* (bed bug), *Periplaneta americana*, *Blatella germanica* and *Blatta orientalis* (cockroaches), Ants -*Tapinoma melanocephalum* (Ghost ant), *Solenopsis geminata*, *Monomorium latinode*, *Paratrechina longicornis* and *Camponotus variegatus*
4. **Pests of stored products:** *Sitophilus oryzae* (Rice weevil), *Callosobruchus maculatus*, *C. chinensis* (Pulse beetles), *Corcyra cephalonica* (Rice moth).
5. **Major pests of crops:**
Rice: *Nilaparvata lugens* (Brown planthopper); **sugarcane:** *Chilo* spp. (Shoot & stem borers); **coconut:** *Oryctes rhinoceros* (Rhinoceros beetle), *Rhynchophorus ferrugineus* (Red palm weevil); **mango:** *Sternonchetus mangiferae* (Mango Seed Weevil); **coffee:** *Xylotrechus quadripes* (Coffee white stem borer), *Hypothenemus hampei* (Coffee berry borer); **cotton:** *Helicoverpa armigera* (American Bollworm), *Spodoptera litura* (Tobacco caterpillar); **vegetables:** *Henosepilachna vigintioctopunctata* (Spotted leaf beetle), *Leucinodes orbonalis* (Brinjal shoot & fruit borer), *Diaphania indica* (Cucumber defoliator); **polyphagous pests:** White grubs (root grubs), *Holotrichia* sp. and *Leucopholis* sp., *Aleurodicus dispersus* (Spiralling whitefly), mealybugs.
6. **Vectors and parasites:** *Anopheles*, *Culex*, and *Aedes* adult mosquitoes. Parasites: *Leishmania* sp., *Plasmodium* spp. and *Wuchereria* spp.
7. **Parasitoids, predators and biopesticides:**
 - i. Biocontrol agents- *Cryptolaemus montrouzieri* (Ladybird beetle), *Leptomastix dactylopii* (parasitoid wasp), *Trichogramma* spp. (egg parasitoid).
 - ii. Indigenous natural enemies: Predators- *Spalgis epius* (Apefly) and *Chrysoperla carnea* (Lacewing), Parasitoids-Hymenopteran parasitoids, biopesticides.
8. **Insect traps:** Pheromone traps- Funnel, Sleeve, Del-Ta, Wota, Fligh, Cross-vane, and bucket traps, Volatile traps- Bottle trap and Multiple plastic cup trap, pheromone dispensers (polythene vials, polythene sachet, rubber septa) and light traps.
9. Screening of insecticides and Abbott's correction.
10. Rearing techniques of pests (house fly, storage pests, mealybugs) and biocontrol agents (lace wings, lady bird beetles, parasitoids, insect pathogens)
11. Field visit: Identification and listing (at least 10 species each) of harmful and beneficial insects. Lab visit: important entomology laboratories in and around Bangalore.

Unit 1: Aquatic environment:**13hr**

- a) Classification of freshwater habitats - Lotic and lentic ecosystems- lakes, rivers
- b) Structure of aquatic ecosystems - Morphometry - lake and river.
- c) Physical factors (light and temperature). Chemical factors. Biological zonation

Oceanography:

- a) General features, waves, tides, current and upwelling.
- b) General submarine topography
- c) Physico-chemical properties of Estuary – Salinity and temperature.

Unit 2: Aquatic community:**13hr**

- a) Plankton - Classification, distribution and migration
- b) Benthos – Animal communities in lakes, stream and reservoir

Management and conservation of aquatic habitats:

- a) Management of lakes - Eutrophication, control of nutrient and macrophyte biomass
- b) River management and restoration
- c) Conservation of wetlands.

Unit 3: Fish diversity and body design:**13hr**

- a) Distribution of freshwater fishes of India.
- b) Distribution of marine fishes of India.
- c) Gas exchange and swimming –
 - i. Air breathing organs and gas bladder
 - ii. Swimming modes (fin versus body trunk, swimming muscles and tail beat)

Fish growth and reproduction:

- a) Growth curves
- b) Reproduction- Reproductive cycles, reproductive behaviour, parental care, Pheromones.

Unit 4: Fish culture practice in India:**13hr**

- a) Freshwater carps (Indian major and minor) and Lacustrine fish culture (ornamental).
- b) Mariculture – Finfish and shellfish culture.
- c) Hybridization and cryopreservation
- d) Fish and shell fish diseases, prophylaxis and therapy.

Fishery technology and economics:

- a) Fishing gears and crafts
- b) Fishing industry in India (including preservation and processing)
- c) Fishery research Institutes in India.
- d) Fishery economics.

Bibliography

1. Beaven C R 1998 Handbook of the freshwater fishes of India (Narendra Publishing House)
2. Biswas K P 1996 A Text Book of Fish, Fisheries and Technology, 2nd ed. (Narendra Publishing House)
3. Brown E and Margret 1957 Physiology of Fishes Vol I & II (Academic Press, Inc. Publishers)
4. Daniels R J R 2002 Freshwater fishes of Peninsular India (Universities press)
5. Jhingran V 1982 Fish and Fisheries of India 2nd Ed (Hind Publication Comp.)
6. Jobling M 1995 Environmental Biology of Fishes (Chapmen and Hall)
7. Kumar S and Thembre M 1996 Anatomy and Physiology of Fishes (Vikas Publishing House)
8. Lagler K F, Bardach J E, Miller R R and Passino D R 1977 Ichthyology (John Wiley & Sons)
9. Nikolsky G V 1999 Ecology of Fishes (Allied Scientific Publishers)
10. Pillay T V S 1990 Aquaculture – Principles and practices (Fishing News Books Oxford)
11. Selvamani B.R & Mahadevan R.K 2008 Freshwater fish farming (Campus Books International)

PRACTICALS:**52hr****Hydrobiology**

1. Use of limnological equipments such as Secchi's disk, Sedgewickrafter counting cell, Ekman's dredge (grab), Water sampling bottle and Plankton net.
2. Determination of total alkalinity and dissolved organic matter
3. Determination of total hardness, calcium and magnesium.

Fisheries

4. Determination of length-weight analysis in fishes.
5. Determination of absolute and relative fecundity in fishes.
6. Identification of important fish parasites (external and internal).
7. Identification of fishing gears and fish byproducts.
8. Identification of fish food organisms (phyto and zooplankton, benthic invertebrates)

HC-204: HISTOLOGY AND HISTOCHEMISTRY**52hr****Unit 1:****13hr**

- a) Bone development, growth, calcification, remodeling and healing of fracture
- b) Thick and thin skin – structure and functions. Blood – Red Blood corpuscles, white blood corpuscles, platelets and Haemopoiesis or Blood cell development. Histological structure and functions of Lymph node, tonsil, Thymus and spleen

Unit 2:**13hr**

- a) Muscular system – Structure of smooth Muscle
- b) Skeletal and cardiac muscle fibers
- c) Muscle tendon attachment and Intercalated disc
- d) Nervous system – organization, function and classification of nerve fibers. Neuron types, Sense organs – structure and functions of Eye, Ear, and Nose.

Unit 3:**13hr**

Reproductive system – Histological structure and functions of the Ovary, uterus, oviduct, vagina and mammary gland Histological structure and function of the Testes, vas deferens, epididymus, cowpers gland and seminal vesicle. Endocrine glands – Structure and functions of pituitary, thyroid, adrenal and pineal gland.

Unit 4: Histochemistry:**13hr**

Histochemical localization of proteins, lipids, carbohydrates and PAS reaction and the factors affecting the rate of reaction and Nucleic acids.

Bibliography

1. Berne. R.N. and Levy. M.N. 1996 Principles of physiology (Mosby year book)
2. Bloom and Fawcett. D. 1972 Text book of histology 10th ed.
3. David H.C. 1987 Histology 9th ed. (Horper International Pub)
4. Histochemical, (Harper and Row: London and John Weatherwill Inc. Tokyo Incl Mission: USA)
5. McManus J.F.A. and Mowry R.W. 1960 Staining methods.
6. Pearse A G E 1968 Histochemistry Vol.1 & 2 (Churchill Livingstone: London)

PRACTICALS:**52hr**

1. Sectioning and staining of mammalian tissues for histological and histochemical Studies – Intestine, Liver, Kidney, Ovary and Testes
2. Histology of following tissues: 1) Foetal skin 2) Tongue-filiform, fungiform, circumvallate and foliate papillae. Taste buds, 3) Salivary gland 4) Hyaline cartilage 5) Spleen 6) Thymus 7) Adrenal 8) Trachae 9) Cowper's gland 10) Vagina 11) Lymph gland 12) Thyroid 13) Iod cells 14) Seminal vesicles 15) Retina
3. Histochemical detection of proteins by mercury bromophenol blue.
4. Histochemical detection of lipids by Sudan Black B.
5. Histochemical detection of carbohydrates by periodic acid Schiff's reagent
6. Histochemical detection of DNA in tissues by Feulgen.

SC205: BIOSTATISTICS AND COMPUTER APPLICATION**40hr****PART-A: BIOSTATISTICS**

1. Introduction: Data reduction. Frequency distribution, graphical representation, measures of central tendency and dispersion. **4 hr**
2. Probability: Conditional probability, addition and multiplication rules of probability, probability distributions: binomial, Poisson and normal distributions, applications. **6 hr**
3. Simple linear regression and correlation, random sampling. **4 hr**
4. Tests of Significance: Tests for single population mean, two means. Variance, proportions, Chi-square tests, Analysis of variance. **6 hr**

PART-B: COMPUTER APPLICATIONS

1. Computer fundamentals, computer organization, computer hardware and computer software, programming languages, operating system, input and output devices computer memory. Word processing, spread sheet calculations and databases, an over view of MS -OFFICE. **6hr**
2. Computer networks, internet and its applications **4hr**
3. Introduction to bio informatics: Applications gene, genome and genomics, proteomics. **6hr**
4. Sequence Analysis; Nucleotide and proteomic sequence analysis, homology sequence analysis-BLAST, PASTA, pair wise sequence analysis, multiple sequences-CLUSTLAW, phylogenetic analysis. **4hr**

Bibliography

- 1) Bailey, N.T.J., 1994. Statistical Methods in Biology-II Ed., Cambridge University Press.
- 2) Samuel, M.L., 1991. Statistics for Life Sciences, Dellen Publishing Co, San Francisco.
- 3) Arthur M. Lesk, 2002. Introduction to Bioinformatics, Oxford University Press, New York
- 4) Satish Jain, O level made simple: information Technology, BPB publications

HC 301: BIOLOGY OF REPRODUCTION

52hr

Unit I : Gonadal Development and Reproduction: Sexual Differentiation and development: Sex determination, gonadal-sex determination, differentiation of sex accessory ducts and glands, differentiation of external genitalia **6 hr**

Unit II : Male Reproduction: Histoarchitecture of testis, spermatogenesis; Function of sertoli and Leydig cells; Seminiferous epithelial cycle and wave length, hormonal control of spermatogenesis Functional morphology and hormonal regulation of epididymis, vas deferens, prostate gland, seminal vesicle, Cowper's gland; Biology of spermatozoa & biochemistry of semen; Biological actions of androgens. **14 hr**

Unit III : Female Reproduction: Anatomy of female reproductive system, histoarchitecture of the ovary, folliculogenesis, follicular atresia, ovulation, corpus luteum, estrous and menstrual cycle and their hormonal regulation, biological action of estrogens. Implantation, gestation, parturition and lactation: types of implantation, sequential events and hormonal regulation, delayed implantation, placenta-histophysiology and endocrine functions, endocrine control of Pregnancy and Parturition, Lactation-Development of mammary glands, Lactation and its hormonal control. **19 hr**

Unit IV : Modern trends in Reproduction: Fertility control in male and females-Natural methods, barrier methods, intrauterine devices, hormonal contraceptives, surgical and immunological approaches: Amniocentesis: ARTs-Ovulation induction, IVF, gamete intra-fallopian tube transfer, surrogate pregnancy, gestational carrier. Reproductive toxicology: toxicology of male and female reproductive systems, Effects of environmental chemicals and metals on reproductive systems. **13 hr**

Bibliography

1. Adiyodi and Adiyodi 1977: Reproductive biology of invertebrates (IBH; New Delhi)
2. Adler. N.T. 1981: Neuroendocrinology of Reproduction.
3. Austin C.R & Short. R.V 1972: Reproduction in mammals (Cambridge University Press; London)
4. Balin. H and Glasser. S, 1976 : Reproductive Biology (Experia Medica Amsterdam)
5. Birkhead. R.T. David J.H and Pitnick S, 2009: Sperm biology-An evolutionary perspective (Elsevier/Academic press).
6. Chester-Jones I (1987): fundamentals of Comparative vertebrate Endocrinology (Plenum Press: NY)
7. Gorbman A Dickhoff W.W. Vigna S R C Clark N.R and Ralph C I 1983: comparative Endocrinology (John Willey and Sons; NY)
8. Gupta. 1999: Reproductive Immunology (Narosa publications)
9. John D.1995: Endocrinology and Metabolism (Academic press: USA)
10. Jones R.E. 1980. The vertebrate Ovary ,Comparative biology and evolution (Plenum press)
11. Jones R.E. 1991. Human Reproductive biology (II Ed). (Academic press: USA)
12. Johnson M.H. Evertitt B.J. & Brockmann H.J. 2008: Essential Reproduction 4th Edn (Blackwell Science; USA)
13. Knobil.E. and Neil. J.D. 1998 :L Encyclopidia of Reproduction-Vol. I-IV, Academic press
14. Knobil.E & Neil J.D 1994 : The physiology of Reproduction-II Ed, Vol. I & II, reven Press Ltd
15. Peters H and Mc Matty K.P. 1980. the ovary (Granada Publishing House; NY)
16. Richard E.J.1991. human Reproductive biology (II Ed) (Academic Press; USA)
17. Sarkar. H.B.D 1996. Principles of Vertebrate reproductive Biology
18. Schimdi 1971. Biology of Lactation (Academic press: USA)
19. Saidapur.S.K.1989. (Ed) Reproductive cycles of Indian vertebrates. (Allied Publishers Ltd. New Delhi)
20. Wooding P & Burton G. 2008. Comparative Placentation; Structure, functions & evolution (Springer).

PRACTICALS:**52 hr**

1. Anatomical studies of reproductive systems in crab, fish, frog, pigeon and rats.
2. Histological study of testis, ovary and accessory reproductive organs in rat.
3. Identification of types of placenta sections
4. Study of sperm morphology, abnormalities and sperm count in rat
5. Study of pseudopregnancy in rat
6. Study of contraceptive devices
7. Study of pregnancy detection test in clinical samples
8. Demonstration of Surgical techniques-
 - a) Ovariectomy
 - b) Hysterectomy in albino rat

HC 302: POPULATION GENETICS AND EVOLUTIONARY BIOLOGY**52 hr****Unit I: Introduction:****13hr**

a) Brief history of Population Genetics, b) Gregor Mendel, c) Charles Darwin. **Quantitative Genetics:** a) Frequency distribution – Mean, Variance and standard deviation, c) Correlation, d) Regression

Unit II: Evolutionary forces that affect the allelic frequency:**13hr**

a) Allele frequency, b) Mutation, c) Migration, d) Selection – Stabilizing, Directional, Disruptive, Balancing, Frequency dependent, density dependent, Group selection and kin selection, e) Genetic drift f) Gene pool, g) Hardy –Weinberg equilibrium and its application.

Unit III: Isolating mechanisms:**13hr**

Classification – (a) Geographic isolation (b) Reproductive isolation – (i) Pre mating isolation – Climatic, Seasonal, Habitat, Ethological (ii) Post mating isolation – gametic mortality, zygotic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown.

Inbreeding and Heterosis: a) Genetic consequences of inbreeding, b) Heterosis.

Unit IV: Speciation:**13hr**

a) Concepts of species, b) Models of speciation (c) Phyletic gradualism and punctuated equilibrium

Molecular phylogenetics: (a) Construction of phylogenetic tree (b) Phylogenetic inference – Distance method, Parsimony method, Maximum likelihood method c) Molecular clock.

Human phylogeny: Hominid evolution - Anatomical, Geographical and Cultural.

Bibliography

1. Dobzhansky, Th., F. J. Ayala, G. L. Stebbins & J. M. Balentine, 1976. Evolution. Surjeet Publication, Delhi
2. Freeman, S and J. C. Herron 1998. Evolutionary Analysis. Prentice Hall, New Jersey.
3. Futuyma D. J. 1986. Evolutionary Biology. Sinauer Associates, INC. Sunderland.
4. Smith, J. M. 1998. Evolutionary Genetics. Oxford University Press. Oxford.
5. Stearns, S. C. and R. F. Hoekstra 2000. Evolution: An Introduction. Oxford University Press, Oxford.
6. Strickberger, M. W. 1990. Evolution. Jones and Bartlett Publishers. Boston

PRACTICALS:**52hr**

- 1) Demonstration of natural selection.
- 2) Studies on inversion polymorphism in *Drosophila*.
- 3) Study of Quantitative characters: Sternoplurals - mean, standard deviation.
- 4) Study of Quantitative characters: Acrostichals - mean, standard deviation
- 5) Study of population genetics problems.
- 6) Studies on homologous and analogous organs.
- 7) Study of phylogenetic tree.

PAPER 303: ANIMAL ECOLOGY AND ENVIRONMENTAL BIOLOGY

52hr

Unit 1: Introduction: Concepts, principles, scope, basic elements of ecosystems. **13hr**
Population ecology: Structure, growth curves, concept of carrying capacity, Oscillation. Energy flow at population level ; population interaction.

Community ecology: Structure, diversity, patterns in community, biotic community concept. Ecological dominance; Community analysis, Ecotone. Community production – primary and secondary production.

Unit 2: Applied ecology: **13hr**
Exobiology, space travel and life support system.
Conventional and Non-conventional energy resources – Wind, solar, bio-fuel and others. Nuclear Energy – Nuclear power plants. Ecological tourism.
Ecological model: Nature of ecological models; goals of model building; basic tools in model building. Approaches to development of models. Energy flow models.

Unit 3: Environment quality, its issues and sustainable development: **13hr**
Sources, causes and control of air, water, soil pollution with special reference to present scenario in India. Natural hazards (Earthquakes, cyclones and volcanoes); Tsunami; Soil erosion (degradation and fertility); Forest fires, mining and quarrying. Bioremediation of xenobiotics – principles and types (Phyto-, Zoo- and microbial - remediation).

Unit 4: Human health and hazards: **13hr**
Chemical and Biological hazards in developed and developing countries. Risk analysis – Scope, general aspects, communication and management. Occupational health hazards. Industrialization, urbanization and globalization

Bibliography

1. Boughey A S 1971 Fundamental Ecology (Intext Educational Pub.) Pp 222
3. Chenn P 1999 Ecology (John Murray Pub.) Pp 213
4. Collin R, Townsend, Harper J L, and Michael Begon 2000 Essentials of ecology. (Blackwell Sci. Comp.) pp 552
5. Dilip R 1998 Environment management with Indian experience (APH Pub. Cor.)
6. Krebs C J 1994 Ecology (Harper and Collins) pp 801
7. Mackenzie A, Ball A S and Virdee S R 2002 Ecology (Viva Books Pvt. Ltd.) P 339
8. Miller Jr and G T 2002 Living in the environment (Wardsworth, Brooks/Cole)
9. Mishra P C 1990 Fundamentals of Air and Water Pollution (Ashish Publishing House)
10. Odum E P 1971 Fundamentals of ecology (WB Saunders Co.) Pp 574
11. Paul W P 1948 Limnological Methods (The Blakistan Co.)
12. Raven P H, Berg L R, Johnson G B 1993 Environment (Saunders College Pub.) pp 569
13. Singh M C 2000 Environment Protection and the Law (Ashish Publishing House)

PRACTICALS:

104hr

PART- A: ANIMAL ECOLOGY AND ENVIRONMENTAL BIOLOGY

52hr

1. Estimation of chloride, sulphate in water samples.
2. Estimation of the B.O.D. (Demonstration) and C.O.D. in water sample
3. Estimation of carbon-di-oxide and oxygen during photosynthesis in aquatic bodies.
4. Thermal lag studies in terrestrial habitat.
5. Estimation of soil biomass and soil organisms. (Wet and dry methods)
6. Population ecology- Population growth in Paramecium/ Drosophila larva.
7. Identification and observation of - a) Hospital waste (Solid waste) b) Pollution indicator species

PART- B: BIODIVERSITY AND BEHAVIOUR

52hr

1. Identification and listing of wild animals (at least 10 species of invertebrates and 20 species of vertebrates from different groups) found in any localities and assigning IUCN status.
2. Identification – Critically endangered, endangered and vulnerable animals of India.
3. Biodiversity indices -Problem solving: Shannon -Wiener diversity index, Simpson index, Sorenson index, Evenness index, and Marglef species richness index.
4. Tools and apparatus used in behavioural studies- Skinner box, Puzzle box, Y tube, wind tunnel, olfactometer, pollen trap.
5. Grooming behaviour in cockroaches/house flies.
6. Courtship behaviour in *Drosophila*.
7. Habituation in mosquito larvae.
8. Phototactic response in *Drosophila* adults or storage pests.
9. Chemotaxis in *Drosophila* adults.
10. Social organization in insects: Termite nest and caste system. Nest construction behaviour and altruism in red ants.
11. Field activities: field visits- zoos, sanctuaries, national parks, forests. Planting and maintaining of larval host plants of different butterfly species in JB campus.

OE 304: ECONOMIC ZOOLOGY

40hr

Unit 1: Apiculture, Sericulture, Pisciculture and Poultry:

24hr

- a) Different species of honey bees, bee plants, pollen calendar, bee keeping and management practices, bee products, pests of honey bees and their management.
- b) Different silkworm species and their host plants, silkworm rearing and management practices, pests of silkworms and their management.
- c) Types of fishery: Marine, Inland. Prawn culture. Composite fish culture, Induced breeding and Hybridization. Fish and shell fish diseases and their control measures. Pearl culture – Oysters and pearl formation. Composition, colour, size and quality of pearl.
- d) Poultry: types and breeds, biology of fowl, methods of rearing and maintenance, diseases of poultry and their control measures.

Unit 2: Pests and their management:

8hr

Insect pests and vectors: major insect pests of crops (rice, coconut, sugarcane, mango) and house hold pests (cockroaches, bedbug, house fly) – nature of damage and management. Important insect vectors of human diseases (malaria, filaria, leishmania, dengue, chikungunya, encephalitis)-biology and management. Rodent pests and their management. Integrated Pest Management (IPM).

Unit 3: Biodiversity, wildlife and conservation:

8hr

Global and local trends of biodiversity, Mega biodiversity countries, hot spots and heritage sites, Threats to biodiversity. Wildlife-scope and importance, IUCN Red list categories. Habitat diversity of Indian wildlife, endemic and threatened species. Conservation- sanctuaries, national parks, zoological parks, botanical gardens, biodiversity Act, Indian wildlife (Protection) Act.

Bibliography

1. Ananthkrishnan T N and Shivaramkrishnan K G 2008 Ecological entomology: Insect life in odd environment (Scientific Pub.: India)
2. David B V and Ananthkrishnan T N 2004 General and Applied Entomology. 2nd Edition (Tata McGrw-Hill Publ. Co. Ltd.: New Delhi)
3. Dent D R 1998 Insect pest management (Westville Publishing House: Delhi)
4. Eldridge B 2004 Medical entomology (Springer)
5. Ellermann J R 1961 The Fauna of India (Manager of Publications: New Delhi)
6. Fenemore P G and Prakash A 2009 Applied Entomology (New Age Publishers: New Delhi)

7. Gee E P 1964 The Wildlife of India (Collins: London)
8. Ghosh A K 2008 Biodiversity (The Energy and Resources Institute: Delhi)
9. Graham M J 1993 The hive and the honey Bee (Dadant and Sons, Hamilton: Illinois)
10. Gullan P J and Cranston P S 2010 The insects- An outline of entomology 4th Edition (Blackwell Science Ltd)
11. Gurr G M, Wratten S D and Snyder W E (Eds) 2012 Biodiversity and Insect Pests: Key Issues for Sustainable Management (Wiley-Blackwell)
12. Hill D S 1993 Agricultural insect pests of the tropics and their control (Cambridge University Press)
13. Hill D S 2008 Pests of crops in warmer climates and their control (Springer)
14. Krishnan M 1972 India's Wildlife (Bombay Natural History Society: India)
15. Leveque C and Mounolou J 2003 Biodiversity (John Wiley and Sons, Ltd.: West Sussex, England)
16. Lovejoy T E and Hannah L 2006 Climate change and biodiversity (The Energy and Resources Institute: Delhi)
17. Magurran A E and McGill B J 2011 Biological Diversity: Frontiers in Measurement and Assessment (Oxford University Press: USA)
18. Mani M S 1974 Ecology and Biogeography of India (Junk Publ.: The Hague)
19. Menon V 2003 A field guide to Indian mammals (Dorling Kindersley Pvt. Ltd.: India)
20. Nair S.C 1991 Southern Western Ghats: A biodiversity conservation plan (Indraprastha Press: New Delhi)
21. Nair S M 1992 Endangered animals of India and their conservation (National Book Trust: Delhi)
22. Prater S H 1971 The Book of Indian Animals (Bombay Natural History Society: India)
23. Primack R B 2010 Essentials of Conservation Biology (Boston University: Sunderland, Massachusetts, USA)
24. Shah J H, 1975 Introduction to Wildlife Management (McGraw Hill :New York)
25. Stracey P D 1963 Wildlife in India: Conservation and Control (Ministry of Agriculture, Govt. of India)
26. Zachos F.E. and Habel J.C. (Eds) 2011 Biodiversity Hotspots: Distribution and Protection of Conservation Priority Areas (Springer)

HC 401: GENERAL ENDOCRINOLOGY

52hr

Unit I: Invertebrate endocrine systems: Annelida and arthropoda- A comparative account, chemistry of invertebrate hormones. Neuroendocrine control of metamorphosis in insects and amphibians.

10hr

Unit II: Morphology, synthesis and action of hormones of endocrine glands- thyroid, parathyroid, adrenal gland, pancreas and pineal glands, Pathophysiology- cretinism, Cushing syndrome and Addison's disease.

14hr

Unit III: Autocrine, paracrine and endocrine secretions - an overview of mammalian endocrine system. a) Hypothalamus- structure and functions, hypothalamo-hypophysial portal system, regulation of hypophysial secretions. b) Hypophysis- comparative morphology of pituitary gland (fishes – mammals). Functional cell types of hypophysis, hypophysial hormones and physiological hormones. Pathophysiology-pituitary dwarfism, gigantism and acromegaly

14hr

Unit IV: Mechanism of hormone action: types of hormone receptors (membrane bound cytoplasmic and nuclear receptors) regulation of receptor number, signal transduction- secondary messengers, cyclic AMP, prostaglandin, cAMP mediated pathways, genomic mechanism of hormone action- thyroid and steroid hormones, termination of hormone action.

14hr

Bibliography

1. Bentley, P.J. 1994: Comparative vertebrate endocrinology –III Ed. Cambridge Univ. Press (NY)
2. Chandra. S. Nagi : Introduction to Endocrinology PHI (New Delhi)
3. Degroot. L.J. and Neill, J.D. 2001: Endocrinology-IV Ed, Vol. I-III. W.B. Saunders company(Ed)
4. Gorbman and Beru .1962: A text book of Comparative Endocrinology
5. Highman and Hill 1972: Comparative Endocrinology of Invertebrates
6. Machodley Prentree.1996: Comparative endocrinology and reproduction (Narosa publication house; New Delhi)
7. Mandal. A. 1994: Handbook of Neuroendocrinology, EMKAY publications
8. Nelson. R.J. 1995: An Introduction to behavioural endocrinology Sinauer Associates, Inc.
9. Nooris. D.O. 1996 :Vertebrate endocrinology IIIrd Ed., Academic Press
10. Pickford G.E & Atz W.J.1957: The Physiology of Pituitary gland of fishes (Zoological Survey; NewDelhi)
11. Saidapur.S.K.1989: (Ed) Reproductive cycles of Indian vertebrates. Allied Publishers Ltd, New Delhi
12. Turner. C.D. and Bugnara.J.T 1976: General Endocrinology., W.B. Saunders
13. Zarrow M.X and Mc Carthy. J.L 1964: Experimental endocrinology (Academic Press; New York).

PRACTICALS:

26hr

1. Display of endocrine glands-pituitary, thyroid, thymus, pineal, parathyroid, pancreas & adrenal glands.
2. Permanent slide preparations of above endocrine glands using different staining methods.
3. Histological studies of reproductive systems in crab, fish, frog, pigeon and rats (slides)
4. Study of estrous cycle in rat- vaginal smear method
5. Demonstration of following technique:
 - a) Thyroidectomy
 - b) Adrenalectomy in a suitable animal (rat/mice).
6. Effect of unilateral or bilateral adrenalectomy on serum GOT activity in albino rat.

Unit I:

Molecular Architecture of Eukaryotic cell and their environment: a) Biomembranes – Composition, Structure, Fluid mosaic model b) Basic functions – Permeability, Osmotic principles, Carrier protein, Channel proteins, Passive transport, Active transport, Na⁺/K⁺ Pump, Pinocytosis, Phagocytosis. **Cells and their environment :** a) Cell- matrix adhesion – Collagen, Proteoglycan, Fibronectin, Laminins, Integrins, Extra cellular matrix b) Cell-cell adhesion - Cadherins, Desmosomes, Gap junction. **13hr**

Unit II:

Molecular mechanisms of cell division and Special chromosomes: a) Ultrastructure and organization of – Centrosome, centromere and Kinetochore b) Microtubule and their dynamic instability c) Microtubule associated proteins, d) Metaphase and Anaphase movements e) Cytokinesis.

Special Chromosomes - (a) Polytene chromosome- Structural organization and significance b) Lampbrush chromosomes- Structural organization and significance c) Supernumerary chromosomes **Sex determination** – a) Sex chromosomes b) Chromosomal basis of sex determination, **Heterochromatin** – a) Types and Function. **13hr**

Unit III:

Recombinant DNA Technology: a) Tools of Recombinant DNA Technology- Restriction enzymes, cloning vectors, Plasmids, Phages, Viruses b) Methods of Introduction - Transformation, Transduction, Transfection, Electroporation, Biolistics, microinjection, liposome fusion b) Applications of Recombinant DNA Technology and Transgenic animals. **13hr**

Unit IV:

Molecular cytogenetic techniques: a) Banding – C, G, R and Fluorescence b) Autoradiography c) *In situ* hybridization – FISH, Chromosome painting. **13hr**

Bibliography

1. Alberts B., Bray D, Lewis J, Raff M, Roberts K and Watson JD. 2001. Molecular Biology of the Cell. Garland publishing Inc. New York
2. Cooper GM. 1997. The Cell: A Molecular Approach. Sinauer Associates. Inc
3. Daniel J, Lodish H & Baltimore D 2000. Molecular Cell Biology. Scientific American Books, Inc: USA
4. Glick BR and Paternak JJ. 1994. Molecular Biotechnology-Principles and applications of Recombinant DNA. ASM-Press: Washington DC
5. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J. 2000. Molecular Cell Biology Freeman WH and Co. New York

PRACTICALS:

26hr

- 1) Vital staining of mitochondrial using Yeast cells.
- 2) Preparation of salivary gland chromosomes of *Drosophila melanogaster*.
- 3) Study of Meiotic chromosomes- *Poecilocus pictus*.
- 4) Study of Barr body in human using buccal smear
- 5) Isolation of cellular DNA by rapid method using Cauliflower/ Sheep liver.
- 6) Demonstration of Agarose gel electrophoresis.

HC 403: APPLIED PHYSIOLOGY

52hr

Unit 1: Physiology of Ageing and Oxidative Stress

13hr

- a) Concepts and major theories of aging, ageing and apoptosis - concept and significance Invertebrate models of aging- *Saccharomyces cerevisiae* (Brewer's yeast), *Coenorhabditis elegans* (nematode) and *Drosophila melanogaster* (fruit fly).
- b) Oxidative stress- Toxic effects of oxygen, free radicals, oxygen and its derivatives- reactive oxygen species and reactive nitrogen species. Antioxidants and defense mechanisms-enzymic and non-enzymic.
- c) Oxidative stress-related diseases- Alzheimer's disease, Parkinson's disease, Atherosclerosis, diabetes, cancer and hypertension.

Unit 2: Physiology of Muscle

13hr

- a) Skeletal muscle- microanatomy of skeletal muscle, cross-bridge cycle and regulation of contraction, energetics of contraction, fiber types, fatigue. Adaptations of muscle to exercise.
- b) Smooth muscle - anatomy and contractile apparatus, cross-bridge regulation in smooth muscle.
- c) Cardiac muscle – anatomy and regulation of contraction, atrial conduction and atrioventricular conduction.

Unit 3: Cellular Neurophysiology:

13hr

- a) Structure and classification of nerve fibers. Types of Glial cells and their importance. Sodium-potassium pump. Nerve impulse- Generator potential, action potential, origin of nerve impulse and its propagation. Properties of nerve fibers-All or none law, rheobase, chronaxie and refractory period. Voltage and patch clamp studies. Molecular aspects of sodium and potassium channels. Role of voltage and ligand-gated channels in excitable tissues.
- b) Concept of electrical and chemical transmission. Synapse function: Ultra-structure, properties. Biochemistry of synapse, mechanisms of neurotransmitter release and inactivation and role of auto receptors. Dale's principle and its implications.
- c) Functional aspects of neurotransmitter systems- distribution of adrenergic transmitters, cholinergic transmitters, GABAergic transmitters and amino acid transmitters. Neuropeptides and their physiological role.

Unit 4: Neuronal Integration and Sensory Mechanisms.

13hr

- a) Neural circuits, Concepts of facilitation, spatial and temporal summation. Neural coding, input and its implications.
- b) Integration at unit and circuit level, integration at associative level. Concept of labeled lines. Mechanisms of synaptic plasticity, degeneration and regeneration of nerve fibers.
- c) Physiology of sensory mechanisms involved in perception, mechanoreception, chemoreception, photoreception –visual pigments, compound and vertebrate eye.

Bibliography

1. Arking A Biology of Aging (Sinauer Associates Inc) 2002
2. Azar NJ and Arain AM. Focus on Clinical Neurophysiology.(Lippincott Williams & Wilkins) 2009
3. Bengtson VL and Schaie KW. Handbook of Theories of Aging (Springer Publishing Company) 1999
4. Berne RM and Levy MN Principles of Physiology (Mosby, Inc, Missouri) Third Edition 2000
5. Chaudhuri SL Concise Medical Physiology (New Central Book Agency (P) Ltd.: Calcutta), 2002
6. Cowan, W.M., Südhof, T.C., Stevens, C.F., Synapses (The Johns Hopkins University Press) I Edition, 2003.
7. Dantzer WH. Handbook of Physiology (Oxford University Press) 1997
8. DiGiovanna AG. Human Aging: Biological Perspectives (McGraw-Hill, Inc) 2000
9. Gordon M Neurobiology (Oxford University Press) 1988
10. Hall ZW. An introduction to Molecular Neurobiology (Sinauer Assoc. Inc Publishers) Second Edition 2002
11. Halliwell B and Gutteridge JMC. Free Radicals in Biology and Medicine (Oxford Press) 2002
12. Hille, B., Ionic channels of Excitable Membranes.(Sinauer Associates, Sunderland, Massachusetts).2008
13. Kandel R, Schwartz JH and Jessell TM. Principles of Neural Science (Elsevier) Fourth Edition 2000.

14. Kanungo MS Genes and Aging (Cambridge University Press) 2002
15. Kay I Neuroscience (Bios Scientific Publishers Oxford) 2000
16. Longstaff A Neuroscience (Bios Scientific Publishers Ltd. Oxford) 2002
17. Petty HR Molecular Biology of Membranes (Plenum Press) 2003
18. Prosser CL Comparative Animal Physiology (WB Saunders and Company) 1985
19. Ruckebusch, Phaneuf and Dunlop. Physiology of Small and Large Animals (Decker Inc) 2003
20. Schmidt-Nielsen K. Animal Physiology- Adaptation and Environment (Cambridge University Press) 2000
21. Speralakis N Cell Physiology (Academic Press) 2000
22. Stuart, G, Spruston, N and, Hausser, M., Dendrites (Oxford University Press) Second Edition, 2008.
23. Timiras P. Physiological Basis of Aging and Geriatrics (Informa Health Care Inc. N.Y) Fourth Edition, 2007

PRACTICALS:

26hr

1. Estimation of rate of oxygen consumption by aquatic animals under salinity stress
2. Estimation of rate of oxygen consumption by aquatic animals under varying ambient temperatures
3. Estimation of rate of oxygen consumption by aquatic animals under oxygen deficiency
4. Determination of respiratory quotient of an air breathing animal at different temperatures.
5. Blood glucose level under environmental stresses in a vertebrate species.
6. Preparation of standard graph for a neurotransmitter (Acetylcholine / catecholamines)
7. Demonstration of neurobehavior of a mammal
8. Analysis of blood samples for clinical markers (Hepatic/renal/cardiac)

HC404: DEVELOPMENTAL BIOLOGY

52hr

Unit 1: Gametogenesis and early development:

13hr

Physiological, chemical and molecular events during a) Oogenesis & b) Spermatogenesis c) Fertilization d) Cleavage e) Competence and induction f) Primary, secondary and abnormal inductions g) Mesoderm induction in amphibians h) Totipotency and nuclear transplantation experiments.

Unit 2: Embryonic and body plan:

13hr

a) Embryonic polarity – Drosophila and Amphibia, b) Gastrulation in Amphibia and Mammal c) Epithelial morphogenesis, cytoskeletal components, microtubules, microfilaments and intermediate filaments. Teratology and its significance in histogenesis. d) Erythropoiesis, pancreogenesis and myogenesis

Unit 3: Regeneration:

13hr

Physiological changes during regeneration in planarians and amphibians, Life cycles and Evolution of Developmental pattern a) The frog lifecycle, b) Developmental pattern of Metazoan, c) Multicellularity – Evolution of differentiation .

Unit 4: Early development:

13hr

Early development of vertebrates- a) Fish b) Birds c) Mammals. Early development of Invertebrates- a) Seaurchin b) Snails c) Tunicates d) Nematodes

Bibliography

1. Balinsky.B.L. 1971 Introduction to Embryology (Saunders College pub.)
2. Beril N.J. and Karpotata.G. 1972 Development (Mc Graw Hill Publications)
3. Browder L.W. Erickson Co-ordinator A and Jeffery N.R. Developmental Biology (Saunders College publications)
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5. Gilbert S.F. 1997 Developmental Biology Fifth edn. (Sinquer Associates Publications, Sunderland)

6. Gilbert. S.F. and Raunio. A.M. 1977 Embryology – Constructing the Embryo (Sinauer Associates Inc. Pub: Sunderlands USA)
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8. Guilbert S.F. and Mussach. S. 1999 Developmental Biology (Singer Associates Publication, Sunderland)
9. Raff. R.A. 1996 The shape of Life Genes Development and the Evolution of Animal (University Chicago Press: Chicago)
10. Stack. J.M.W. 1983 From Egg to Embryo: Determinants events in early development (Cambridge University Press)
11. Tickle. C. 2003 Patterning in Vertebrate development (Frontiers in Molecular biology) Oxford University Press, USA) pp 268.
12. Wilkins. A.S. 1993 Genetic Analysis of Animal Development (New York).

PRACTICALS:

26hr

1. Observation of slides of the early development of fish, frog, chick
2. Preparation of whole mount of chick blastoderm.
3. Morphogenetic movements of cells in-vitro during development of chick
4. Observations of sections of testis and ovary of fish, frog and rat.
5. Organogeny in chick and pig – observation of sections
6. Demonstration of live observation of drosophila embryogenesis.

M.Sc. ZOOLOGY (CBCS Syllabus) : Scheme of Examinations

I SEMESTER

THEORY								PRACTICALS							Total Marks	Total Credits
Paper Code	Title of the Paper	Total Hrs	Hrs/Week	Marks			Credits	Paper Code	Total Hrs	Hrs/Week	Marks			Credits		
				IA	Exam	Total					IA	Exam	Total			
HCT 101	BIOLOGY OF NON-CHORDATES	52	4	30	70	100	4	HCP 101	52	4	15	35	50	2	150	6
HCT 102	BIOLOGICAL CHEMISTRY	52	4	30	70	100	4	HCP 102	52	4	15	35	50	2	150	6
HCT 103	GENERAL PHYSIOLOGY	52	4	30	70	100	4	HCP 103	52	4	15	35	50	2	150	6
HCT 104	GENETICS AND CYTOGENETICS	52	4	30	70	100	4	HCP 104	52	4	15	35	50	2	150	6
SCT 105	BIOLOGICAL DIVERSITY AND ANIMAL BEHAVIOUR	40	3	30	70	100	2	----	----	----	----	----	----	----	100	2
Total		248	19	150	350	500	18		208	16	60	140	200	8	700	26

II SEMESTER

THEORY								PRACTICALS							Total Marks	Total Credits
Paper Code	Title of the Paper	Total Hrs	Hrs/Week	Marks			Credits	Paper Code	Total Hrs	Hrs/Week	Marks			Credits		
				IA	Exam	Total					IA	Exam	Total			
HCT 201	BIOLOGY OF CHORDATES	52	4	30	70	100	4	HCP 201	52	4	15	35	50	2	150	6
HCT 202	APPLIED ENTOMOLOGY	52	4	30	70	100	4	HCP202	52	4	15	35	50	2	150	6
HCT 203	AQUATIC BIOLOGY AND FISHERIES	52	4	30	70	100	4	HCP203	52	4	15	35	50	2	150	6
HCT 204	HISTOLOGY & HISTOCHEMISTRY	52	4	30	70	100	4	HCP204	52	4	15	35	50	2	150	6
SCT 205	BIOSTATISTICS AND COMPUTER APPLICATIONS	40	3	30	70	100	2	----	----	----	----	----	----	----	100	2
Total		248	19	150	350	500	18		208	16	60	140	200	8	700	26

III SEMESTER

THEORY								PRACTICALS							Total Marks	Total Credits
Paper Code	Title of the Paper	Total Hrs	Hrs/Week	Marks			Credits	Paper Code	Total Hrs	Hrs/Week	Marks			Credits		
				IA	Exam	Total					IA	Exam	Total			
HCT 301	BIOLOGY OF REPRODUCTION	52	4	30	70	100	4	HCP 301	52	4	15	35	50	2	150	6
HCT 302	POPULATION GENETICS & EVOLUTIONARY BIOLOGY	52	4	30	70	100	4	HCP 302	52	4	15	35	50	2	150	6
HCT 303	ECOLOGY & ENVIRONMENTAL BIOLOGY	52	4	30	70	100	4	HCP 303	104	8	15	35	50	4	150	8
OE 305	ECONOMIC ZOOLOGY	52	4	30	70	100	4	----	----	----	----	----	----	----	100	4
Total		208	16	120	280	400	16		208	16	45	105	150	8	600	24

IV SEMESTER

THEORY								PRACTICALS							Total Marks	Total Credits
Paper Code	Title of the Paper	Total Hrs	Hrs/Week	Marks			Credits	Paper Code	Total Hrs	Hrs/Week	Marks			Credits		
				IA	Exam	Total					IA	Exam	Total			
HCT 401	GENERAL ENDOCRINOLOGY	52	4	30	70	100	4	HCP 401	26	2	7	18	25	1	125	5
HCT 402	CELL AND MOLECULAR BIOLOGY	52	4	30	70	100	4	HCP 402	26	2	7	18	25	1	125	5
HCT 403	APPLIED PHYSIOLOGY	52	4	30	70	100	4	HCP 403	26	2	7	18	25	1	125	5
HCT 404	DEVELOPMENTAL BIOLOGY	52	4	30	70	100	4	HCP 404	26	2	7	18	25	1	125	5
PR 405	PROJECT			30	70	100	4	----	----	----	----	----	----	----	100	4
Total		208	16	150	350	500	20		104	8	28	72	100	4	600	24

Scheme of Examination for I, II, III and IV Semester (M. Sc. Zoology)

THEORY

Duration of the Examination: **3 Hours**

Part A: Comprising **Four** compulsory questions requiring 50 words answers of **Two** marks each (questions should be from all units).

4x2=8 marks

Part B: Comprising **Four** compulsory questions with internal choice of short essay of 200 words answers, each carrying **Eight** marks ((questions should be from all units; internal choice questions must be within a unit)

4x8=32 marks

Part C: Comprising **Two** Essay questions with internal choice each carrying **Fifteen** marks (questions should be from all units).

2x15=30 marks

Total:	70 marks
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PRACTICAL

Duration of the Examination: **3 Hours**

1. Practical Test proper **30 marks (2-4 credits)/15 marks (1 credit)**

2. Viva voce **5 marks (2-4 credits)/3 marks (1 credit)**

Total	35 / 18 marks
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Internal Assessment:

A. Total 30 marks for each Theory paper

- **Seminar / Assignment** **10 marks**
- **Test (Two)** **20 marks**

Total 30 marks

B. Total 15 marks (2 credits)/ 7marks (1 credit) for each Practical paper

- **10 marks (2 credits) /5 marks (1 credit) for the preparatory practical test**
- **5 marks (2 credits) /2 marks (1 credit) for Record**

Total 15 / 7 marks
