SCHEME AND SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM
B.Sc. WITH ZOOLOGY

	CORE COURSE (12)	**Ability Enhancement Compulsory Courses AEC (2)**	**Skill Enhancement Courses SEC (4)**	**Discipline Specific Elective DSE (4)**
I	CC- Botany I CC-Zoology I CC- Chemistry I	Environmental Science		
II	CC- Botany II CC-Zoology II CC- Chemistry II	English Communication		
III	CC- Botany III CC-Zoology III CC- Chemistry III		SEC-I	
IV	CC- Botany IV CC-Zoology IV CC- Chemistry IV		SEC-II	
V			SEC-III	DSE-Botany I DSE-Zoology I DSE-Chemistry I
VI			SEC-IV	DSE-Botany II DSE-Zoology II DSE-Chemistry II

Discipline Core Courses: Zoology

1. Animal Diversity
2. Comparative Anatomy and Developmental Biology of Vertebrates
3. Physiology and Biochemistry
4. Genetics and Evolutionary Biology

Discipline Specific Electives: Zoology (Any two)

1. FISH AND FISHERIES
2. IMMUNOLOGY
3. WILD LIFE CONSERVATION AND MANAGEMENT
4. AQUATIC BIOLOGY

Skill Enhancement Courses: Zoology

1. Apiculture
2. Aquarium Fish Keeping
3. Aquatic Biology
4. Research Methodologies

CORE COURSE I
ANIMAL DIVERSITY
THEORY (CREDITS 4)

Unit 1: Kingdom Protista 04
General characters and classification up to classes; Locomotory Organelles and locomotion in *Paramecium*

Unit 2: Phylum Porifera 04

Unit 3: Phylum Cnidaria 03
General characters and classification up to classes; Polymorphism in Hydrozoa

Unit 4: Phylum Platyhelminthes 03
General characters and classification up to classes; Life history of *Taenia solium*

Unit 5: Phylum Nemathelminthes 05
General characters and classification up to classes; Life history of *Ascaris lumbricoides*

Unit 6: Phylum Annelida 03
General characters and classification up to classes; Metamerism in Annelida

Unit 7: Phylum Arthropoda 05
General characters and classification up to classes; Metamorphosis in Insects, Structure of omatidium

Unit 8: Phylum Mollusca 04
General characters and classification up to classes; Ctenidium and Pulmonary Sac in *Pila*

Unit 9: Phylum Echinodermata 04
General characters and classification up to classes; Water-vascular system in Asteroidea

Unit 10: Protochordates 02
General features and Phylogeny of Protochordata

Unit 11: Agnatha 02
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces 04
General features and Classification up to orders; Osmoregulation in Fishes

Unit 13: Amphibia 04
General features and Classification up to orders; Parental care

Unit 14: Reptiles 04
General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in vipers

Unit 15: Aves 05
General features and Classification up to subclass; Air sacs & Respiration in *Columba*

Unit 16: Mammals 05
Classification up to subclass; Origin of mammals

Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition" & for 12 Nelson, J. S. *Fishes of the World* (2006)

ANIMAL DIVERSITY

PRACTICAL **(CREDITS 2)**

1. Study of the following specimens:
Amoeba, *Paramecium, Scypha, Obelia, Physalia, Taenia solium,* Male and female *Ascaris lumbricoides, Aphrodite*, *Nereis, Pheretima, Hirudinaria, Macrobrachium, Carcinoscorpius, Julus*, *Periplaneta, Apis dorsata, Chiton, Pila, Lamellidens, Loligo, Sepia, Octopus, Ophiura, Echinus, Cucumaria* and *Antedon, Balanoglossus, Branchiostoma, Petromyzon, Pristis, Torpedo, Catla Exocoetus, Ichthyophis, Salamandra, Duttaphyrnus, Rachophorus, Hemidactylus, Chamaeleon, Draco, Calotes, Vipera, Naja, Psittacula, Passer, Pycnonotus, Alcedo, Pteropus, Funambulus,Suncus.*

2. Study of the following permanent slides:
Study of life history stages of *Taenia,* T.S. of Male and female *Ascaris*

3. An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa.

SUGGESTED READINGS

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

CORE COURSE II
COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

THEORY (CREDITS 4)

Unit 1: Integumentary System 04
Integument: general structure and its derivatives in mammals

Unit 2: Skeletal System 03
Types of visceral arches

Unit 3: Digestive System 04
Structure and Function of Bovine Ruminant Stomach

Unit 4: Respiratory System 05
Brief account of Gills, Accessory Respiratory Organs in Fishes

Unit 5: Circulatory System 04
Evolution of heart and aortic arches

Unit 6: Urinogenital System 04
Types of kidneys, Urinogenital ducts in vertebrates

Unit 7: Nervous System 03
Comparative account of brain in carp, toad, Garden Lizard and Pigeon

Unit 8: Sense Organs 03
Functions of different types of sensory receptors in fish and reptiles

Unit 9: Early Embryonic Development 12
Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; early development of frog (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula).

Unit 10: Late Embryonic Development 10
Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

Unit 11: Genetic Control of Development wrt Inborn errors 08

Chromosome Changes in Human (Numerical and Structural) with reference to Down syndrome, Turner syndrome, Klinefelter syndrome & Thalassemia

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

PRACTICAL **(CREDITS 2)**

1. Osteology:
   i) Skull: Toad, Pigeon, Guinea pig.
   ii) Vertebrae, Girdles: Toad, Pigeon, Guinea pig.
   iii) Limb Bones: Toad
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Examination of gametes - frog/ rat - sperm and ova through permanent slides or photomicrographs.
5. Study of developmental stages in Chick embryo (24, 48, 72 h)

SUGGESTED READINGS

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

CORE COURSE III
PHYSIOLOGY AND BIOCHEMISTRY
THEORY (CREDITS 4)

Unit 1: Nerve and muscle 08 Structure of a neuron, action potential and its propagation in myelinated and non-myelinated nerve fibres, Molecular and chemical basis of muscle contraction

Unit 2: Digestion 05
Physiology of digestion in the alimentary canal; Absorption of lipids

Unit 3: Respiration 05
Transport of Oxygen and carbon dioxide in mammalian blood

Unit 4: Excretion 05
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system 06
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, cardiac cycle

Unit 6: Reproduction and Endocrine Glands 07
Spermatogenesis, Oogenesis & hormonal controls; menstrual cycle and hormonal control, Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism 08
Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism 05
Biosynthesis and β oxidation of palmitic acid

Unit 9: Protein metabolism 05
Transamination, Deamination and Urea Cycle

Unit 10: Enzymes 06
Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

PHYSIOLOGY AND BIOCHEMISTRY

PRACTICAL **(CREDITS 2)**

1. Preparation of hemin crystals from
2. Staining of Blood-film of Man.
3. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
4. Study of permanent slides of liver, lung, kidney
5. Qualitative tests to identify carbohydrates in given solutions (Glucose, Fructose & Sucrose,)

6. Estimation of total protein in given solutions by Lowry's method.

SUGGESTED READINGS

1. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
2. •Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
3. Guyton, A.C. And Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
4. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
6. Murray, R.K., Grinner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

CORE COURSE IV (CREDITS 4)
GENETICS AND EVOLUTIONARY BIOLOGY
THEORY

Unit 1: Introduction to Genetics 03
Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension 08
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co- dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance, Chi Square test

Unit 3: Linkage, Crossing Over and Chromosomal Mapping 09
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses

Unit 4: Mutations 07
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations

Unit 5: Sex Determination 04
Chromosomal mechanisms, dosage compensation

Unit 6: History of Life 02
Origin of Life

Unit 7: Introduction to Evolutionary Theories 05
Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution 05
Types of fossils, Incompleteness of fossil record, Phylogeny of horse

Unit 9: Processes of Evolutionary Change 09
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive)

Unit 10: Species Concept 06
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro-evolution 05
Macro-evolutionary Principles (example: Darwin's Finches)

Unit 12: Extinction 06
Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY

PRACTICAL

(CREDITS 2)

1. Study of Mendelian Inheritance using suitable examples. Verify the results using Chi-square test.
2. Study of gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Charts:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

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

DISCIPLINE SPECIFIC ELECTIVE COURSES

DSE 1

FISH AND FISHERIES

THEORY (Credits 4)

UNIT 1: Introduction and Classification: 06

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

UNIT 2: Morphology and Physiology: 16

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Bioluminescence; Schooling; Parental care; Migration

UNIT 3: Fisheries 12

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

Unit 4: Aquaculture 20

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

UNIT 5: Fish in research 06

Transgenic fish, Zebrafish as a model organism in research

PRACTICAL (Credits 2)

1. Study of *Petromyzon, Myxine, Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo rohita, Labeo kalbasu, Heteropneustes, Anabas*
2. Study of different types of scales (through permanent slides/ photographs).
3. Study of crafts and gears used in Fisheries from Video/ photograph/ models
4. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total suspended solids, Total dissolved solids
5. Demonstration of induced breeding in Fishes (video/ field tour)
6. Demonstration of parental care in fishes (video/ slide show)
7. Project Report on a visit to any fish farm/ pisciculture unit/ Aquarium fish rearing farm.

SUGGESTED READINGS

1. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
2. D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK
von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands

3. C.B.L. Srivastava, Fish Biology, Narendra Publishing House
4. J.R. Norman, A history of Fishes, Hill and Wang Publishers
5. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

DSE 1

IMMUNOLOGY

THEORY (Credits 4)

Unit 1: Overview of Immune System 10
Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity 10
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive (Artificial and natural Immunity), Active (Artificial and natural Immunity), Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

Unit 3: Antigens 08
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

Unit 4: Immunoglobulins 10
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis

Unit 5: Major Histocompatibility Complex 06
Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation

Unit 6: Cytokines 04
Properties and functions of cytokines, Therapeutics Cytokines

Unit 7: Complement System 04
Components and pathways of complement activation.

Unit 8: Hypersensitivity 03
Gell and Coombs' classification and brief description of various types of hypersensitivities

Unit 9: Vaccines 05
Various types of vaccines.

PRACTICAL (Credits 2)

1. Demonstration of lymphoid organs from photograph/ model/ pre dissected specimen.*
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. Ouchterlony's double immuno-diffusion method.

5. ABO blood group determination.
6. Demonstration of ELISA/ Immuno-electrophoresis

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

SUGGESTED READINGS

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
3. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

DSE 2
WILD LIFE CONSERVATION AND MANAGEMENT

THEORY (Credits 4)

Unit 1: Introduction to Wild Life 06

Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

Unit 2: Evaluation and management of wild life 08

Habitat analysis, Physical parameters: Topography, Geology, Soil and water

Unit 3: Population estimation 16

Population density, Natality, Birth rate, Mortality, Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Pug marks and census method.

Unit 4: Management planning of wild life in protected areas 10

Estimation of carrying capacity; Eco tourism/ wild life tourism in forests; Concept of climax persistence; Ecology of perturbance.

Unit 5: Protected areas: In-situ and ex-situ conservation 20

National parks & sanctuaries, Community reserve; important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

Concept and practice; captive breeding; re-establishment and relocation, advance technology in service of endangered species, zoos and botanical gardens, gene banks or germplasm reserves, Marine Protected areas.

PRACTICAL (Credits 2)

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Quadrat analysis and plotless sampling method
5. Line transect & point transect monitoring for abundance and diversity estimation of mammals and bird

SUGGESTED READINGS

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

DCE 2
AQUATIC BIOLOGY

THEORY (Credits 4)

UNIT 1: Aquatic Biomes 10

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology 20

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology 15

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources 15

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

PRACTICAL (Credits 2)

1. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
2. Determine the amount of Turbidity/ transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.
3. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
4. A Project Report on a visit to a Sewage treatment plant/ Marine bio-reserve/ Fisheries Institutes.

SUGGESTED READINGS

1. Anathakrishnan : Bioresources Ecology 3rd Edition

Goldman : Limnology, 2nd Edition

1. Odum and Barrett : Fundamentals of Ecology, 5th Edition
2. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
3. Wetzel : Limnology, 3rd edition
4. Trivedi and Goyal : Chemical and biological methods for water pollution studies
5. Welch : Limnology Vols. I-II

SEC 1

APICULTURE

THEORY (Credits 2)

Unit 1: Biology of Bees 05

History, Classification and Biology of Honey Bees; Social Organization of Bee Colony

Unit 2: Rearing of Bees 10

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth; Bee Pasturage; Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies 05

Bee Diseases and Enemies; Control and Preventive measures

Unit 4: Bee Economy 02

Products of Apiculture Industry and its Uses (Honey, Bee Wax, Propolis), Pollen etc.

Unit 5: Entrepreneurship in Apiculture 08

Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.

Bisht D.S., Apiculture, ICAR Publication.

Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.

SEC 2

AQUARIUM FISH KEEPING

THEORY(Credits 2)

Unit1: Introduction to Aquarium Fish Keeping 05

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes 10

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes: Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes 06

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation 03

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium 06

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

SEC 3

AQUATIC BIOLOGY

THEORY (Credits 2)

UNIT 1: Aquatic Biomes 10

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology 20

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology 15

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources 15

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

SUGGESTED READINGS

1. Anathakrishnan : Bioresources Ecology 3rd Edition
2. Goldman : Limnology, 2nd Edition
3. Odum and Barrett : Fundamentals of Ecology, 5th Edition

4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
5. Wetzel : Limnology, 3rd edition
6. Trivedi and Goyal : Chemical and biological methods for water pollution studies
7. Welch : Limnology Vols. I-II

SEC 4
RESEARCH METHODOLOGY

THEORY (Credits 2)

Unit 1: Foundations of Research 05

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs applied

Unit 2: Research Design 08

Need for research design: Features of good design, important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3: Data Collection, Analysis and Report Writing 12

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

Unit 4: Ethical Issues 05

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
C. R. Kothari: Research Methodology, New Age International, 2009
Coley, S.M. and Scheinberg, C.A. 1990, “Proposal writing”. Stage Publications.