UNIVERSITY OF NORTH BENGAL

Syllabus for B.Sc. (Honours & General)

under revised new course structure

for Part - I, Part - II and Part - III

in

ZOOLOGY

(Revised syllabus introduced w.e.f. academic session 2014-2015)

UNIVERSITY OF NORTH BENGAL

Raja Rammohunpur, Darjeeling - 734 013

West Bengal, India.

SYLLABUS

for

B.Sc. (Honours & General)

under revised new course structure for
Part - I, Part - II and Part - III
in

ZOOLOGY

UNIVERSITY OF NORTH BENGAL

Raja Rammohunpur, Darjeeling - 734 013
West Bengal, India.

Revised Syllabus

B. Sc. ZOOLOGY (Honours)
2014-2015
University of North Bengal

Part I [*Total 180 marks: part marking in brackets*]

Paper I:
Time: 3hrs. Full Marks: 60
- i) Origin of life (10)
- ii) Systematics (10)
- iii) Animal Diversity – Part 1: Nonchordates (40)

Paper II:
Time: 3 hrs. Full Marks: 60
- i) Animal Diversity – Part 2: Chordates (40)
- ii) Structural adaptation (10)
- iii) Zoogeography (10)

Paper III (Practical):
Time: 5 hrs. Full Marks: 60
[Based on Paper I & II]

Part II [*Total 280 marks: part marking in brackets*]

Paper IV:
Time: 4hrs. Full Marks: 90
- i) Cell Biology (25)
- ii) Molecular Biology (20)
- iii) Laboratory and Analytical Techniques (20)
- iv) Biochemistry (25)

Paper V:
Time: 4 hrs. Full Marks: 90
- i) Genetics (20)
- ii) Basic Concepts of Immunology (20)
- iii) Animal Physiology (20)
- iv) Endocrinology and Reproductive Biology (30)

Paper VI (Practical):
Time: 5 hrs. Full Marks: 50
[Based on Paper IV]

Paper VII (Practical):
Time: 5 hrs. Full Marks: 50
[Based on Paper V]

Part III [*Total 340 marks: part marking in brackets*]

Paper VIII:
Time: 4 hrs. Full Marks: 80

1. Histology and Histochemistry (25)
2. Developmental Biology & Teratology (25)
3. Adaptation & Evolution (30)

Paper IX:
Time: 4 hrs. Full Marks: 80

i) Ecology (25)
ii) Environmental Biology & Toxicology(30)
iii) Animal Behaviour (25)

Paper X:
Time: 4 hrs. Full Marks: 80

i) Applied Zoology (30)
ii) Conservation Biology & Wild life (30)
iii) General Informatics and Bio-informatics (20)

Paper XI (Practical):
Time: 4 hrs. Full Marks: 50
[Based on Paper VIII & IX with emphasis on Methods of Field Biology]

Paper XII (Practical):
Time: 4 hrs. Full Marks: 50
[Based on Paper X; Data handling (mainly biostatistics) and Field Work & Study Report/Dissertation]

DETAILED SYLLABUS FOR B.SC. HONOURS COURSE IN ZOOLOGY

Part I [*Total 180 marks*: part marking in brackets]

Paper I:

Time: 3hrs. **Full Marks: 60**

i) Origin of life (10)
ii) Systematics (10)
iii) Animal Diversity – Part I: Nonchordates (40)

i) Origin of life

1. Theories of origin of life.
2. Chemical evolution: Miller's experiment, formation of complex organic molecules, protenoids.
3. Origin of organization: coacervates, microspheres, brief idea about origin of protein and nucleic acid, protocell, progenitor.

ii) Systematics

1. New trends in systematic (basic idea): Chemo and Serotaxonomy, Cytotaxonomy, Numerical taxonomy (Phenetics), Cladistics (Phylogenetic systematics).
2. Molecular systematic and DNA finger printing.
3. Nomenclature: Binomial and Trinomial nomenclature; International rules of Zoological nomenclature (brief account).

iii) Animal Diversity – Part I: Nonchordates

- **Five kingdom classification of living organisms**
- **Concepts of classification of animals (brief account):** Classification based on number of cells, tissue or organ system level of organisation, development of germ layers, development of symmetry by cleavage, development of coelom, segmentation in the somite, development of mouth and digestive tract.
- **Detailed study of Nonchordates:**

1. **PROTOZOANS**
   (a) Characteristic features and classification of Kingdom Protista down to phyla.
   (b) Type study: *Paramecium*: morphology and structural organization [as revealed by compound microscopy]; locomotion, nutrition, excretion, osmoregulation and reproduction; conjugation in detail.
   (c) Comparative study of locomotion, nutrition, and reproduction in *Euglena, Paramecium, Plasmodium, and Amoeba.*
2. **METAZOA:** Brief idea about origin, compartmentalization, polarity, and cell specialization.
3. Phylum **PORIFERA**
   (a) Classification with reasons and example of Phylum Porifera down to subclasses.
   (b) Type study: *Scypha* sp.
   (c) General account of canal system and spicules.
4. Phylum **CNIDARIA**
   (a) Classification with reasons and example of Phylum Cnidaria down to subclasses.
   (b) Type study: *Obelia*

(c) Polymormphism in reference to *Physalia.*
(d) Types, distribution, ecology and conservation of coral reefs.

5. Phylum **CTENOPHORA**
   (a) Salient features and diversity of Ctenophora.
   (b) Type study: *Pleurobrachia/ Hormiphora.*
   (c) Affinities and systematic position (in brief).

6. Phylum **PLATYHELMINTHES**
   (a) Classification with reasons and example of Phylum Platyhelminthes down to classes.
   (b) Salient features of *Fasciola hepatica* and *Taenia solium.*
   (c) Life cycles and parasitic adaptations of *Fasciola hepatica* and *Taenia solium.*

7. Super Phylum **ASCHELMINTHES**
   (a) Highlight the heterogeneous nature of Super Phylum Aschelminthes.
   (b) Classification down to phyla.
   (c) Type study: *Ascaris lumbricoides.*

8. Salient features of **Pseudocoelomate Minor Phyla:** Gastrotricha and Rotifera.

9. Phylum **ANNELIDA**
   (a) Classification with reasons and example of Phylum Annelida down to classes.
   (b) Evolution and significance of segmentation.
   (c) General account of coelom, locomotion, and reproduction and development Annelida.

10. Salient features and phylogeny (in brief) of **Echiura** and **Sipuncula**.

11. Salient features and phylogeny of **Onychophora.**

12. Phylum **ARTHROPODA**
   (a) Classification with reasons and example of Phylum Arthropoda down to classes.
   (b) Salient features of Xiphosura.
   (c) Type study: *Periplanata Americana.*
   (d) General accounts of exoskeleton, mouth parts, and vision in Arthropoda.
   (e) Metamorphosis in insects.

13. Phylum **MOLLUSCA**
   (a) Classification with reasons and example of Phylum Mollusca down to classes.
   (b) Type study: *Pila globosa.*
   (c) General accounts of mantle, shell, nervous system and sense organs in Mollusca.
   (d) Adaptive diversity of Cephalopoda.

14. Salient features of **Brachiopoda, Bryozoa** and **Chaetognatha**.

15. Phylum **ECHINODERMATA**
   (a) Classification with reasons and example of Phylum Echinodermata down to classes.
   (b) Origin of pentamerous symmetry.
   (c) General accounts of water vascular system and larva in echinodermata.

16. Phylum **HEMICHORDATA**
   (a) Salient features and phylogeny of Hemichordata.
   (b) Type study: *Balanoglossus.*

Paper II:

Time: 3 hrs. **Full Marks: 60**

i) Animal Diversity – Part II: Chordates (40)
ii) Structural adaptation (10)
iii) Zoogeography (10)

i) Animal Diversity – Part II: Chordates

1. **Introduction:** Chordate characters [fundamental, general and advanced); chordates versus nonchordates; diversity of chordates; classification down to subphyla; salient features of each subphylum.

2. **Subphylum UROCHORDATA**
   (a) Affinities; add a note on neoteny (paedogenesis).
   (b) *Ascidia* (morphology and retrogressive metamorphosis).

3. **Subphylum CEPHALOCHORDATA**
   (a) *Branchiostoma* [=*Amphioxus*] morphology, primitive, degenerate and specialized features (affinities and systematic position to be emphasized).

4. **Division AGNATHA**
   Structural organization of *Petromyzon* [mention Ammocoete larva].

5. **Division GNATHOSTOMATA**
   Super class **PISCES**
   Class **Chondrichthyes** [cartilaginous fishes]
   (a) Classification with reasons and examples down to order (extant groups only).
   (b) Type study: *Scoliodon.*
   Class **Osteichthyes** [bony fishes]
   (a) Classification with reasons and examples down to order (extant groups only).
   (b) Salient features, adaptation, and distribution of Dipnoi.
   (c) Accessory respiratory organs.
   (d) Parental care.

6. Class **Amphibia**
   (a) Classification with reasons and examples down to order (extant groups only).
   (b) Type study: *Duttaphrynus (=Bufo) melanostictus.*
   (c) Parental care.
   (d) Defense mechanism.

7. Class **REPTILIA**
   (a) Classification with reasons and examples down to Suborder (extant groups only).
   (b) Salient features of *Calotes versicolor.*
   (c) Salient features, habit and habitat of 'Big Fours' of Indian snakes.
   (d) Poison apparatus, types of venom, and First Aid to snake bite.

8. Class **AVES**
   (a) Classification with reasons and examples down to Superorder (extant groups only) and some specified Order as: Sphenisciformes, Ciconiformes, Anseriformes, Falconiformes, Galliformes, Psittaciformes, Apodiformes, Piciformes, and Passeriformes.
   (b) Type study: *Columba livia.*

9. Class **MAMMALIA**
   (a) Classification with reasons and examples down to Order (extant groups only) with special reference to Monotremata, Marsupialia, Chiroptera, Primates, Cetacea, Sirenia, Artiodactyla, Perissodactyla, and Proboscidea .
   (b) Dentition in mammals.
   (c) Exoskeletal structures of mammals.

10. Comparative study of brain, heart, aortic arches, and kidney among different classes.

ii) Structural Adaptations

1. Fossorial adaptation.
2. Scansorial adaptation.
3. Cursorial adaptation.
4. Aerodynamics in birds
5. Echolocation in mammals.

iii) Zoogeography

1. Animal Distribution: Cosmopolitan distribution, discontinuous distribution, bipolar distribution and isolated distribution.
2. Barriers to animal distribution: Physical barriers (topographical and climatic); biological barriers.
3. Zoogeographical realms and their characteristic fauna (reptiles, birds and mammals only) with special reference to Oriental realm.

Paper III (Practical): [Based on Paper I & II]
Time: 5 hrs. **Full Marks: 60**

1. Study of the parts of a compound microscope, its proper use and Maintenance.
2. Construction of taxonomic key – for insect and fish (upto order).
3. (a) Preparation of world map to show six zoogeographical realms.
   (b) Preparation of world map to show Wallace line, Weber line and Wallacea
   (c) Locate the distribution of following animals in the world map:
   Peripatus, Lung fishes, *Sphenodon*, Ratite, Hummingbirds (familyTrochilidae), Hornbills, Monotremes, Marsupials, Armadillos, *Alligator, Gavialis,* Ant-eaters (Edentata), Pangolins, Elephant, Rhinoceros, Lion, Tiger, Camel, aardvark (Tubulidentata), lemur.
4. Identification with reasons (Non-chordates) (Preserved specimens/models/pictures as available to be used):
   Paramecium, Amoeba, Euglena, Vorticella, Scypha, Hyalonema, Spongilla, Hydra, Obelia, Aurelia, Metridium, Physalia, Valella, Fungia, Gorgonia, Fasciola, Taenia solium, Echinococcus, Ascaris, Sipunculus, Neanthes, Aphrodite (Sea mouse), *Chetopterus, Metaphire, Tubifex, Hirudinaria, Echiurus* (Spoon worm), *Sipunculus* (Peanut worm), *Peripatus, Carcinoscorpius* (horseshoe crab), *Lepas, Balanus, Sacculina, Eupagurus*, Prawn, Crab, Millipede, Scorpion, *Lepisma* (silverfish), *Scirpophaga, Helopeltis, Belostoma*, Cicada, Mantis, Chiton, Patella, *Sepia, Loligo, Octopus*, Sea Lily, Star fish, Brittle star, Sea cucumber, Sea urchin, *Balanoglossus*.
   Larva: Ephyra, Nauplius, Zoea, Mysis, Megalopa, Glochidium, Trochophore, Veliger, Bipinnaria.
5. Identification with reasons (Preserved specimens/models/pictures as available to be used):

Ascidia, Salpa, Doliolum, Branchiostoma, Myxine, Petromyzon,Scoliodon, Sphyrna,Trygon, Narcine, Cynoglossus, Catla catla, Labeo rohita, Cirrhina mrigala, Clarias batrachus, Heteropneustes fossilis, Anabas testudineus, Anguilla bengalensis, Hippocampus, Exocoetus, Ichthyophis, Hyla, Rhacophorus, Ambystoma, Chamaeleon, Gecko, Calotes, Draco, Hydrophis, Naja, Vipera russelli, Bungarus caeruleus, Echis carinatus, Crotalus, Lesser whistling teal, Pintail, Ruddy Shelduck, Brahminy kite, Shaheen falcon, Indian Longbilled vulture, Siberian crane, Bronzewinged Jacana, Great Indian bustard, Pied kingfisher, Blue Jay/Roller, Redbreasted Parakeet, Hill Myna, Purple Sunbird, Flying Squirrel, Clouded Leopard, Fishing Cat, Musk Deer, Nilgiri Tahr, Lion-tailed Macaque, Hoolock Gibbon.

Larva: Ammocoete, Tadpole, Axolotl.

6. Identification of Bones:

Fish: Precaudal and caudal vertebrae.

Amphibia: All axial and appendicular bones of toad.

Reptilia: Skull of *Chelonia, Calotes*, and poisonous snake; atlas, precaudal and caudal vertebrae of snake.

Bird: All axial and appendicular skeleton of *Columba.*

Mammal: All axial and appendicular skeleton of *Cavia;* skull of *Canis.*

Part -II (Total 280 marks: part marking in brackets)

Paper IV:
Time: 4hrs. **Full Marks: 90**

i) Cell Biology (25)
ii) Molecular Biology (20)
iii) Laboratory and Analytical Techniques (20)
iv) Biochemistry (25)

i) Cell Biology

1. Cell as a unit
2. Structure & function of cell membrane
3. Structure and function of Intracellular organelles: Nucleus. Mitochondria, Lysosome, Peroxisome, Vacuoles, Endoplasmic reticulum, Cytoskeleton
4. Cell cycle: Steps of cell cycle, their regulation, mitosis and meiosis.

ii) Molecular Biology

1. Structure of Nucleic acids: DNA, RNA.
2. DNA replication, recombination, repair.
3. RNA synthesis and processing.
4. Protein synthesis and post translational modification.

iii) Laboratory and Analytical Techniques

1. Gene cloning and genetic engineering.
2. Cell & tissue culture techniques.
3. Transgenic animal & strain identification technique (Brief idea only).
4. Biosensors and their applications.
5. Colorimetry, Spectrophotometry, separation technique: cell fractionation. (Homogenization and centrifugation), chromatography (Paper & TLC and HPLC), electrophoresis (SDS-PAGE, Agarose gels) (principle and uses/application only).

iv) Biochemistry

1. Concept of pH: Henderson-Hasselbalch equation
2. Structure and function of basic biomolecules: Carbohydrates, lipids, protein
3. Molecular bonds and forces of interactions: Van der Waals, electrostatic, hydrogen bonding, covalent bond, hydrophobic and hydrophilic interaction
4. Glycolysis, Oxidative Phosphorylation, Energy transducers
5. Enzymes, mechanism of enzyme catalysis
6. Conformation of nucleic acids, t-RNA, micro-RNA
7. Metabolism of carbohydrates, lipids, amino acids, nucleotides

Paper V:
Time: 4 hrs. **Full Marks: 90**

i) Genetics (20)
ii) Basic concepts of Immunology (20)
iii) Animal Physiology (20)
iv) Endocrinology and Reproductive Biology (30)

i) Genetics

1. Mendelism, Crossing Over, Linkage.
2. Extra-chromosomal inheritance.
3. Concept of gene: Allele, Multiple Allele, Pseudoallele and Complementation Test.
4. Sex determination & Barr body.
5. Human Genetics: Syndromes (Turner, Klinefelter, Patau, Marfan and Cat-cry), Inborn errors) Phenylketonuria, Alcaptoneuri, Albinism, Multifactorial Diabetes.

ii) Basic concepts of Immunology

1. Innate & adaptive immunity.
2. Cell mediated & Humoral immunity.
3. B & T cells, cell mediated effector functions.
4. Autoimmunity, hypersensitivity.
5. Immune response to virus (HIV), Bacteria (TB) & Parasite (Plasmodium).
6. Vaccines & their success in human health management.

iii) Animal Physiology

1. Digestion & absorption mechanism.
2. Blood cells, Hemopoiesis, plasma function.
3. Heart tissue, cardiac cycle, regulation of heart beat, ECG-principle.
4. Positive, negative & double respiration; exchange & transport of gases.
5. Gross anatomy of brain & spinal cord, central peripheral nervous system & function; nervous transmission of impulse.
6. Types of kidney & mechanism elimination of nitrogenous wastes. Regulation of water balance by excretory system in representative fish, amphibian, reptilian, bird, mammal.
7. Endocrine glands, basic mechanism of hormone action.
8. Temperature regulation in Mammals (role of hypothalamus).

iv) Endocrinology and Reproductive Biology

1. Neuroendocrine organs and hormones in insects and crustaceans.
2. Vertebrate endocrinology: i) Classification of hormones, Endocrine glands (Pituitary, Adrenal, Pineal, Thyroid, Parathyroid, Gastro-intestinal, Pancreas, and Gonadal) and their hormones (brief account).
3. Concepts of neurosecretion: Hypothalamus, Hypophysial interactions, Hypothalamus releasing and inhibiting hormones.
4. Hormonal action: Mechanism of hormone action at the level of cell membrane (insulin); at the level of enzyme located in cell membrane (adrenaline and peptide hormones); at the level of organelles (thyroxine); at the level of genes (steroids); positive and negative feedback regulation; Hormone receptors.
5. Gametogenesis.
6. Endocrine regulation of Reproductive Physiology (Oestrous & Menstrual cycle).

Paper VI (Practical):

Time: 5 hrs. **Full Marks: 50**

Tissue processing and Micro techniques:

1. Use of camera lucida, stage and ocular micrometer for cell drawing, measurement and magnification calculation.

2. Cell culture (paramecium).
3. Tissue homogenization (Chick liver) and centrifugation.
4. Tissue preparation for histological study (fixation to cutting), Staining of histological tissues.

Molecular Biology:
1. Qualitative isolation of DNA from goat liver by Mamur's Method.
2. Estimation of DNA by Diphenylamine reaction.

Histological and Analytical Techniques:
1. Histochemical Techniques: PAS for carbohydrate, Fuelgen Reaction for Nucleic acid.
2. Paper chromatography and thin layer chromatography for amino acids separation.
3. Double staining of histological tissue: Ileum, liver, pancreas, thyroid, kidney, testis, ovary; and their identification.

Biochemistry:
1. Qualitative detection of specific carbohydrates, proteins and fats.
2. Quantitative estimation of total proteins by Lowry's Method.
3. Quantitative estimation of Carbohydrate (by Anthron Reagent) (Chick liver).
4. Quantitative estimation of cholesterol.

Paper VII (Practical):

Time: 5 hrs. **Full Marks: 50**

Genetics:
1. Study of meiosis from grasshopper testis.
2. Preparation and identification of Barr body.
4. Pedigree analysis.

Immunology:
1. Separation of lymphocytes from human blood.
2. ABO blood grouping and RH typing.

Physiology:
1. Estimation haemoglobin.
2. TC of RBC, WBC.
3. Differential Count.
4. Blood pressure detection (Ausculatory Method).
5. BT and CT (Capillary Method).

Part III [*Total 340 marks*: part marking in brackets]

Paper VIII:

Time: 4 hrs. **Full Marks: 80**

i) Histology and Histochemistry (25)
ii) Developmental Biology & Teratology (25)
iii) Adaptation, Behaviour & Evolution (30)

i) Histology and Histochemistry

1. Kinds of major tissue types and their function.
2. Histological details and function of Liver, Pancreas, Adrenal, Kidney, Testis, Ovary, Thyroid.
3. Tissue Fixatives: additive and non-additive, composition of common fixatives used for chromosome preparation, for protozoans, for organs meant for histological study, cryopreservation.

ii) Developmental Biology & Teratology

1. **Fertilization:** External fertilization, prevention of polyspermy, and activation of egg metabolism in Sea Urchins; capacitation and prevention of polyspermy in mammal.
2. **Types of eggs:** Classification of eggs based on: the amount of yolk (micro, meso & macrolecithal), the distribution (iso, centro & telolecithal), presence or absence of shell (cleidoic & non-cleidoic) with examples; egg membranes (primary, secondary, tertiary).
3. **Cleavage:** Types of cleavage with examples – based on planes (meridional, vertical, equatorial & latitudinal); based on amount of yolk (holoblastic & meroblastic); based on development (determinate & indeterminate); based on pattern (radial & spiral).
4. **Development of Frog:** Cleavage, blastulation & fate map, Gastrulation, Neurulation and notochord formation, mesoderm and coelom formation, hormonal control of metamorphosis.
5. **Development of Chick:** Structure of egg, cleavage, blastulation and fate map, gastrulation, development and functions of extra embryonic membranes; development of heart, kidney and eye.
6. **Placentation:** Types, physiology and functions.
7. **Parthenogenesis:** Definition, types (Facultative, obligatory, cyclic and complete, arrhenotoky, thelytoky and artificial) and significance.
8. **Teratology:** Environmental disruption of animal development (alcohol, drugs, Nicotine and chemicals).

iii) Evolutionary Biology & Protective Adaptation

1. **Theories of evolution:** Lamarck's theory and its criticism, Neolamarckism; Darwin's theory and its criticism, Neo Darwinism.
2. **Modern concepts of evolutionary forces:** Genetic basis of evolution, genetic drift, punctuated equilibrium, Hardy-Weinberg equilibrium.
3. **Nature of evolution:** Adaptive radiation and Divergent evolution (Darwin's finches), Convergent evolution, Preadaptation.
4. **Evolution of Horse.**
5. **Colouration, mimicry and their survival value.**
6. **Speciation, Isolation.**

Paper IX:

Time: 4 hrs. **Full Marks: 80**

i) Ecology (25)
ii) Environmental Biology & Toxicology (30)
iii) Animal Behaviour (25)

i) Ecology

1. Ecosystem Ecology and Energetics: Energy flow and energetics of ecosystem; Energy transformations and energy transfer; Laws of thermodynamics.
2. Biogeochemical cycles: Gaseous cycle - carbon and nitrogen cycles; sedimentary cycle.
3. Limiting factors: Basic concepts - Leibig's law of minimum - Shelford's law of tolerance, combined concept of limiting factors.
4. Population Ecology: Properties of population - density, natality, mortality, age distribution, biotic potential, environmental resistance and carrying capacity, population growth forms, J and S shaped curves, migration, emigration and immigration.
5. Community Ecology: Biotic community - definition, characteristics and classification, species diversity, fluctuations, stratification, succession, ecotone and edge effect.
6. Population interactions: Intraspecific and interspecific associations - Positive and negative interactions: Mutualism, Commensalism, Parasitism, Predation, and Competition.

ii) Environmental Biology and Toxicology

1. Pollution: Source and effects of major pollutants of air, water and soil.
2. Toxicants and Public health hazards
   (a) Toxic chemicals (pesticides, automobile emissions, heavy metals, fertilizers, food additives, xenobiotics, endocrine disrupters, radioactive wastes).
   (b) Levels of toxicity- Acute, sub acute, chronic, LD 50, LC 50
   (c) Common bacterial poisoning (botulism).
3. Man and Environment
   (a) Sustainable development (in brief)
   (b) Destruction of habitat and its consequences - wetland, paddy fields, forest, river encroachment, ecological impacts of tourism.

iii) Animal Behaviour

1. Brief history, scope and branches.
2. Patterns of behavior:
   (a) Innate behaviour (orientation taxes/ kinesis), simple reflexes and instincts, motivation;
   (b) Learned behaviour - habituation, conditioned reflex, trial and error learning; latent learning, imprinting, insight learning, memory and learning.
3. Biological clocks / rhythms: Photoperiod, circadian rhythm; migration, navigation and homing instinct; diapause, hibernation and aestivation (in brief).
4. Animal communication: Communication by sound (bird's song, echolocation in marine mammals); communication by pheromones; bee dance.
5. Sociobiology: Social group in termites; altruism; kin selection; territoriality.

Paper X:

Time: 4 hrs. **Full Marks: 80**

i) Applied Zoology (30)
ii) Conservation Biology & Wildlife (30)

iii) General Informatics and Bio-informatics (20)

i) Applied Zoology

1. Industrial zoology: Essentials of Aquaculture (Fish & Shrimp), Sericulture (Mulberry silk & Muga silk), Apiculture, poultry (Chicken).
2. Sustainable utilization of Biodiversity resource.
3. Breeding livestock (Cow, goat), marker assisted selection.
4. Production of transgenics & their use in health & agriculture.
5. Tissue & cell culture, immunological considerations for production of vaccines.

ii) Conservation Biology & Wildlife

1. Causes of loss of Indian wildlife; current status of threatened mammals, birds, reptiles, amphibians, butterflies from India.
2. Principles of conservation and management of endangered species.
3. Case study of conservation projects on Tiger, Rhinoceros, Lion, Hoolock gibbon.
4. State diversity Board, National Biodiversity Authority, Convention on Biodiversity.
5. Wildlife Sanctuary, National park, biosphere reserve: objectives and process of creation.

iii) General Informatics and Bio-informatics

1. PCR, polymorphism (DNA fingerprinting), bio-polymer.
2. Chemo-informatics & chemical space, bio-pesticides.
3. Databases and Database Analysis, Primary Databases (Nucleotide sequence. databases – Mention EMBL, DDBJ, Genbank; Protein sequence databases – Mention Swiss Prot, PIR, MIPS).
4. Data acquisition and data analysis.
5. NCBI, EBI, molecular graphic software (RasMol, Clustal X).

Paper XI (Practical):

Time: 4 hrs. **Full Marks: 50**

1. Study of developmental stages of toad embryo.
2. Preparation and identification of whole mounts of chick embryo (24, 48, 72 & 96 hrs).
3. Preparation & identification of histological sections (mammalian) of liver, pancreas, thyroid, testes, ovary, lung, tongue, stomach (cardiac), ileum, skin.
4. Identification of queen, drone worker honey bee.
5. Estimation of dissolved O_2 using Winkler method (in pond and tap waters).
6. Estimation of dissolved CO_2 in pond and tap waters.
7. Estimation of alkalinity of pond and tap waters.
8. Extraction of soil organism by hand picking/sieving, floatation and Berlese funnel method.
9. Study of freshwater planktons.
10. Study of LD_{50}, LC_{50} of small fish using $CuSO_4$.

Paper XII (Practical):

Time: 4 hrs. **Full Marks: 50**

1. Field visit to a Sanctuary/National Park/Sea Shore/Krishi Vikash Kendra/Tea plantation or agricultural land and prepare a report on its resource and their use.

OR

Visit any one farm (fishery/poultry/sericulture/apiary/lac culture) and prepare a comprehensive report on that basis.

2. Dissertation work documenting the biodiversity resource of a block where the college or the residence of the student is located.
3. Knowledge of computer packages for statistical analysis of biodiversity data and graphical presentation of the same.
4. Study infestation of pests in three different crop fields (at different locality) of paddy/jute/tea and compare the effect of pesticide/fertilizer/environmental factor statistically (χ^2/t-test/multiple correlation/ANOVA) using SPSS or Minitab.

Revised Syllabus

B. Sc. ZOOLOGY (General)

University of North Bengal

(2014-15)

Distribution of Marks and Topic allotment

Part I [*Total 150 marks*]

Paper I:

Time: 2 hrs. Full Marks: 50

1. Structural diversity of Non-chordates
2. Structural diversity of Chordates

Paper II:

Time: 2 hrs. Full Marks: 50

1. Biochemistry
2. Cell Biology
3. Genetics

Paper III (Practical):

Time: 3 hrs. Full Marks: 50

1. Mounting
2. Identification of Non-chordate, Chordate specimens
3. Identification of non-chordate sections
4. **Laboratory Note Book**
5. **Viva voce** (Based preferably on Practical set on the day)

Part II [*Total 150 marks*]

Paper IV:

Time: 2 hrs. Full Marks: 50

1. Histology
2. Developmental Biology
3. Endocrinology
4. Immunology

Paper V:

Time: 2 hrs. Full Marks: 50

1. Animal Physiology
2. Molecular Biology

3. Biotechnology
4. Biostatistics

Paper VI (Practical):
Time: 5 hrs. Full Marks: 50

1. Identification with reasons: Endoskeleton, Histology, Embryological stages of Chick.
2. Identification of carbohydrate (Fehling, Bendict, Non-reducing sugar), of protein (Millon's and Biuret).
3. Collection / documentation of data of the experiments: Classification and tabulation of biological data
4. Presentation of data: Graphic representation: Histogram, Frequency Polygon and Frequency Curve; Diagrammatic representation: Line diagram, Bar diagram and Pie diagram
5. Analysis of data: (a) Measures of central tendency: Mean, Median and Mode
   (b) Measures of Dispersion: Range, Mean deviation, SD and SE
6. **Laboratory Note Book**
7. **Viva voce** (Based preferably on Practical set on the day)

Part III [*Total 100 marks*]

Paper VII
Time: 3 hrs. Full Marks: 60

1. Ecology
2. Evolution
3. Applied Zoology

***Paper VIII* (Practical):**
Time: 4 hrs. Full Marks: 40

1. **Identification**: Pre-stained Zooplanktons and Phytoplanktons.
2. **Slide preparation**: Staining and identification of prepared slides of Amphibian/ mammalian organ (i.e. liver, kidney, intestine and skin) using Hematoxylene/Eosin stains.
3. Measurement of pH: (i) Colour chart method (ii) pH meter.
4. Preparation of blood/faecal smear:
   a) Staining of blood film (Rabbit/Rat/Man); Identification of leucocytes and blood parasite; Study of T.C & D.C.
   b) Faecal smear or rectal content of cockroach, toad, cow and study of organism therein.
5. Collection and identification of animals: Preservation of any 5 parasites and 5 pests (Major/Minor)
6. **Laboratory Note Book**
7. **VivaVoce** (Based preferably on Practical set on the day)

DETAILED SYLLABUS FOR B.SC. GENERAL COURSE IN ZOOLOGY

PART 1 [150 Marks]

Paper I

Structural Diversity of Nonchordate and Chordate

Time: 2 hrs. **Full Marks: 50**

1. General characters and classification of the under noted Phyla of Non-chordates with reasons and examples up to the level of sub-class
2. Structural organization and functions in details: General structure, locomotion, feeding, digestion, excretion, circulation, neural integration, reproduction and/or life history of the followings:
   Protozoans: *Amoeba proteas, Entamoeba histolytica, Paramoecium caudatum, Plasmodium vivax* and *P. falciparum*
   Porifera: *Scypha* sp
   Cnidaria: *Obelia sp* and *Aurelia sp*
   Platyhelminthes: *Fasciola hepatica*
   Aschelminthes: *Ascaris lumbricoides*
   Mollusca: *Pila globosa, Achatina fulica*
   Annelida: *Metaphire posthuma* (Eartworm)
   Arthropoda: *Periplaneta americana*
   Echinodermata: *Asterias sp*
3. General characters and classification of Phylum Chordata. Classifiaction with reasons and examples of vertebrate classes up to the level of order for Amphibia, Reptilia and upto the level of subclass for Chondrichthyes, Osteichthyes, Aves and Mammalia.
4. General organization, respiratory, circulatory, excretory, neuronal, reproductive structures, and function of *Branchiostoma, Scoliodon, Bufo, Calotes, Columba* and *Rattus.*
5. Comparative anatomy of gut, heart, kidney, brain of *Channa, Bufo, Columba* and *Rattus.*
6. Integumentary glands in mammals.
7. Scales in fishes.

Paper II

Biochemistry, Cell Biology and Genetics

Time: 2 hrs. **Full Marks: 50**

1. Classification of Carbohydrate, Protein and Lipid.
2. Elementary idea about metabolism of Carbohydrate, Protein and Lipid: Concept of Glycolysis, TCA Cycle, elementary knowledge about electron transport, neoglucogenesis.
3. Vitamins: Sources and deficiency disorders for Vitamins-A, B-Complex, C, E and K.
4. Enzyme: Classification and brief idea about mechanism of Enzyme Action.
5. Ultrastructure and function of Plasma membrane, GERL system, ribosome and mitochondria
6. Chromosome structure of nucleosome model
7. Cell cycle: brief ideas
8. Experimental proof of DNA as genetic material.
9. Autosomal and Sex-linked inheritance in Man: Thalassemia and Haemophilia
10. Linkage: Definition, Incomplete and Complete (Experiment).
11. Crossing over (Genetic & Cytological proof).

12. Mutation: chromosomal changes (structural and numerical), point mutation, Down Syndrome, Klinefelter Syndrome.
13. Sex determination in Drosophila (Bridges Experiment only) and man.

Practical
Paper-III

Time: 3 hrs. **Full Marks-50**

Staining/slide Preparation and Mounting:
Hydra, *Obelia* Colony, *Cyclops*, *Daphnia*, *Tubifex*, Salivary apparatus (with tongue) of cockroach, mouth parts of cockroach, Placoid, Cycloid and Ctenoid scales, Types of bird feather, Types and variety of mammalian teeth.

Spot Identification:
Non-chordates specimens up to subclass \ with scientific or common names of the specimen:
Amoeba, *Paramoecium*, *Euglena*, *Scypha*, *Hydra*, *Obelia*, *Aurelia*, Sea Anemone, *Taenia solium*, *Fasciola*, *Ascaris lumbricoides*, *Nereis*, *Metaphire* (Earthworm), *Chaetopterus*, *Hirudinaria*, *Macrobrachium*, *Squilla*, *Hippa*, *Balanus*, *Lepas*, *Cyclops*, *Daphnia*, *Periplaneta*, *Locust*, *Leptocoriza*, *Scorpion*, *Limlus* or *Carcinoscorpians*, *Millipede*, *Centipade*, *Peripatus*, *Chiton*, *Aplysia*, *Pila*, *Achatina*, *Lamellidens*, *Loligo*, *Sepia*, *Octopus*, Star-fish, *Sea-urchin*, *Sea-cucumber*, *Balanoglossus*.

Spot Identification:
Chordate specimen up to order taxon with Scientific or common names of the specimens:
Branchiostoma, *Ascidia*, *Petromyzon*, *Myxine*, *Scoliodon*, *Trygon*, *Narchine*, *Labeo*, *Catla*, *Cirrhina*, *Channa*, *Anabus*, *Heteropneustes*, *Clarias*, *Gymnophiona*, *Necturus*, *Hemidactylus*, *Chamelion*, *Draco*, *Naja*, *Columba* and *Cavia*.

Identification of Non-chordate sections/Specimens: Sections of Sponges (Syconioid and Leuconoid), LS of *Hydra*, LS of *Metridium*, CS *Planaria*, CS of Liver Fluke, CS of Ascaris (male & Female) through gonadal region, CS of *Metaphire* (Earthworm); Larvae: trochophore, glochidium, nauplius, pluteus.

Laboratory Note Book

VivaVoce (Based preferably on Practical set on the day)

Part-II [150 Marks]

Paper-IV: Histology, Developmental Biology, Endocrinology & Immunology

Time: 2 hrs. **Full Marks- 50**

1. Histology of Pituitary, Thyroid, Adrenal and Pancreas and their hormonal functions in mammals.
2. Gametogenesis and fertilization.
3. Hormonal regulation of gametogenesis in males and females.
4. Cleavage and gastrulation in Amphibia.
5. Placenta: Types and Function.
6. Organizer concept.
7. Concept of Protostomia and Deuterostomia.
8. Endocrine glands and hormonal functions in mammals.
9. Endocrine glands and hormones- Classification of Hormones, Mechanism of Hormone action (Elementary idea).
10. Immunology: Innate and induced immunity
11. Cell mediated response, humoral response.
12. Concept of Antigen and Antibody; Vaccine & basis of its function.

Paper V: Animal Physiology, Molecular Biology, Biotechnology & Biostatistics

Time: 2 hrs. **Full Marks- 50**

1. Formed elements in vertebrate blood, Clotting and Coagulation, ABO Blood group and Rh factor.
2. Respiration: Organs of respiration in Vertebrates, Properties and Functions of Respiratory Pigments: Transport of O_2 and CO_2.
3. Physiology of Nerve impulse and Synaptic transmission.
4. Structure of DNA, RNA (with reference to tRNA)
5. Mechanism of DNA replication, transcription and translation in Prokaryotes
6. Basic Concepts of Genetic Engineering: Restriction Enzyme, Plasmid Vector, Strategy for producing Recombinant DNA (with references to pBR322), Transformation (Prokaryotic host).
7. Scope of Genetic Engineering: Introduction, Cell cloning and application.
8. Biostatistics: Definition of Sample and Population: Frequency Distribution and Histogram.
9. Definition and calculation of Mean, Median, Mode, Standard Deviation & Standard Error (problems to be solved).
10.

Practical

Paper-VI

Time: 5 hrs. **Full Marks-50**

Identification of Vertebrate endoskeletons:
Toad: All skeletal parts including hyoid apparatus.
Pigeon: Skull, typical Cervical Vertebra, Synsacrum, Pygostyle with free Caudal Vertebra, Humerus, Carpometacarpus, half of Pelvic Girdle, Tibio-tarsus and Fibula, Tarsometatarsus.
Guineapig: Skull, Lower Jaw, Atlas, Axis, Thoracic and Lumbar Vertebrae, Scapula.

Identification with Reasons of Histological sections of: Stomach, Ileum, thyroid, Liver, Pancreas, Kidney, Testes, Ovary, Spleen, Lung.

Identification with Reasons of Embryological slides of: Chick developmental stages viz., 24, 48, 72, 96 hours of embryo.

Identification of carbohydrate (Fehling, Bendict, Non-reducing sugar), **of protein** (Millon's and Biuret).

Biostatistics: Problems to be set based on theory syllabus.

1. Collection / documentation of data of the experiments: Classification and tabulation of biological data
2. Presentation of data: Graphic representation: Histogram, Frequency Polygon and Frequency Curve; Diagrammatic representation: Line diagram, Bar diagram and Pie diagram
3. Analysis of data: (a) Measures of central tendency: Mean, Median and Mode
   (b) Measures of Dispersion: Range, Mean deviation, SD and SE

Laboratory Note Book

VivaVoce (Based preferably on Practical set on the day)

Part-III [100 Marks]

Paper-VII: Ecology Evolution and Applied Zoology

Time: 3 hrs. **Full Marks- 60**

Ecology

1. Components of Ecosystems.
2. Ecological Factors: Temperature, light, and their effects on organisms.
3. Population Ecology: Natality and Mortality; Growth forms; age pyramids; Distribution types; Regulation of Population Density.
4. Community Ecology: Characteristics; Types; Habitat and Niche concept.
5. Introduction to Animal Behaviour.
6. Importance of wild life study: Wild Life- Its importance. Introduction to major Indian mammals (big games), birds, reptiles (Crocodiles & snakes), and amphibians (*Rana*, *Tylototriton*, Caecilian). Fishes (major carps, murrels & cat fishes of India), Concepts of Sanctuary, National Park, Concept of endemism, extinction risk & Conservation: *in situ* methods; *ex situ* methods.

Evolution

1. Zoogeographical realms and their characteristic fauna with special reference to Oriental region.
2. Theories on the Origin of Life.
3. Lamarckism, Darwinism, Modern Concept of Evolution-Variation and Sources of Variation in a population, Hardy-Weinberg Equilibrium: Forces altering Hardy-Weinberg Equilibrium (Non-Random Mating, Mutations, Migrations, Genetic drift and natural selection): Founder effects and population Bottleneck.
4. Colouration and Mimicry and their adaptive significance.
5. Species: Definition, types: biological, sibling and polytypic.

Applied Zoology

1. **Poultry**: Definition of Poultry and introduction to poultry birds.
   Chicken Poultry: Common Indigenous and Exotic breeds and their characteristics; Principles and management of Poultry including Poultry feed and Poultry diseases.
2. **Sericulture**: types of Indian Silk-moths and their food plants.
   Mulberry sericulture: Important Races of *Bombyx mori* and their Voltinism; Cultivation of important varieties of Mulberry: Life History of *B. mori*; Diseases and their control; silk worm rearing and its required infrastructure.
   Non Mulberry sericulture: An introduction to 'Tasar', 'Muga' and 'Eri' Cultures in India.
3. **Apiculture**: Introduction to Apiculture as an Industry; Names of four common Honey Bees: Organization of a Bee colony: Modern frame Hive Method of Apiculture: Composition and use of Honey.
4. **Fisheries**: Basic ideas different Systems of Aquaculture-Monoculture-Polyculture, Raft Culture, Prawn Culture (Palacomonid and Penacid); Pearl culture. Some Common Disease- Protozoans, Fungal and Bacterial.
5. **Crop Pest Management**: Definition of Pest, Life History, Nature of Damage of the following pests:-
   a. Paddy pests: *Scirpophaga incertulus*
   b. Jute pest: *Anomis sabulifera*
   c. Stored grain pest: *Sitophilus oryzae* (on rice)
   d. Vegetable pest: *Trichoplusia ni* (Cabbage semilooper)
   e. Tea pest: *Helopeltis theivora* (Tea mosquito bug)

6. **Fish and Cattle food**:
Fish food: Types of processed feed-purified, semi-purified and practical. Formulation and preparation of fish food.
Cattle feed: energy and nutritive value of feeds; common feed stuff of India; Processing of cattle feed.

7. **Study of Arthropod Vectors**:
Arthropods are carriers of pathogens and parasites of man: a. Mosquito, b. Sand fly, c. House fly, d. Cyclops, e. Cockroach suggested control/ management programs for the above carriers.

Practical
Paper VIII

Time: 4 hrs. **Full Marks- 40**

1. **Identification**: Pre-stained Zooplanktons and Phytoplanktons.
2. **Slide preparation**: Staining and identification of prepared slides of Amphibian/ mammalian organ (i.e. liver, kidney, intestine and skin) using Hematoxylene/Eosin stains.
3. Measurement of pH: (i) Colour chart method (ii) pH meter.
4. Preparation of blood/faecal smear:
   i) Staining of blood film (Rabbit/Rat/Man); Identification of leucocytes and blood parasite; Study of T.C & D.C.
   ii) Faecal smear or rectal content of cockroach, toad, cow and study of organism therein.
6. Collection and identification of animals: Preservation of any 5 parasites and 5 pests (Major/Minor)
7. **Laboratory Note Book**
8. **Viva Voce** (Based preferably on Practical set on the day)

List of selected books for B.Sc. (General) and (Honours) in Zoology, NBU
(Please use the latest edition available)

Origin of life; Zoogeography and Evolution:

1. Rastogi, V.B. 1997. Evolutionary Biology: Kedar Nath Ram Nath Education Publishers
2. Hall B.K. and Hallgrimsson B. 2014. Strickberger's Evolution: 5th edition. - Burlington, MA : Jones & Bartlett Learning,
3. Futuyama, D. 2009. Evolution. Sinauer Associates, INC.
4. Tiwari, S. K. 1985. Zoogeography of India and South East Asia - CBS Pubs., New Delhi.
5. Cox, C.B. and Moore, P.D. 2009. Biogeography: an ecological and evolutionary approach – Wiley- Blackwell.
6. Chattopadhyay, S. 2002. Life: Origin, Evolution, Adaptation & Ethology –Books & Allied (P) Ltd.

Systematics

1. Mayr, E. and Ashlock, P. D. 1991. Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
2. Dalela, R. C. and Sharma, R. S. 1992. Animal Taxonomy. Jai Prakashnath & Co., Meerut.
3. Hillis, D. M., Moritz, C. and Mable, B. K. (eds) 1996. Molecular Systematics - Sinauer Associates, Sunderland, M.A.

Animal Diversity – Part 1: Nonchordates

1. Barnes, R. D. and Ruppert, E. E., 1994. Invertebrate Zoology. Brooks Cole.
2. Ruppert, E. E., Fox, R. and Barnes R. D. 2003. Invertebrate Zoology: a Functional Evolutionary Approach. Brooks Cole.
3. Barrington, E. J. W. 1981. Invertebrate Structure and function. ELBS and Nelson.
4. Sinha, K. S., Adhikari, S., and Ganguly, B. B. Biology of Animals. 2003. Vol. I. New Central Book Agency (p) Ltd. Kolkata.
5. Jorden, E.L. and Verma P.S. Invertebrate Zoology. 2013 (revised). S. Chand.
6. Brusca, C.R. and Brusca, G.J. 2002. Invertebrates. Sinauer Associates, Inc., Publishers, Sunderland
7. Pechenik J.A. 2000. Biology of Invertebrates, McGraw Hill International Edition
8. Anderson, D.T. 2001. Invertebrate Zoology - 2e, Oxford Uty. Press (Indian Edn.2006)

Animal Diversity – Part 2: Chordates and Structural adaptation

1. Sinha, K. S., Adhikari, S., and Ganguly, B. B. Biology of Animals. 2003. Vol. II. New Central Book Agency (p) Ltd. Kolkata.
2. Jorden, E.L. and Verma P.S. 2010. Chordate Zoology. S.Chand & Co. Ltd
3. Kardong, K. V. 2006. Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
4. Kotpal R.L. 1997. Modern text book of Zoology: Vertebrates, Rastogi Publications
5. Pough, H.F., Heiser J.B. and McFarland, W.N. 1990 and 1991. Vertebrate Life, Macmillan, NY
6. Ray, B. Bhattacharya, B.N., Basu, B and Ray, P. 2003. Zoology vol.I (rev. 2nd edition in Bengali). Abhinaba Prokashan, Kolkata-9
7. Sibley, C.G. and Ahlquist J.E. 1990. Phylogeny and Classification of Birds: A study in Molecular evolution. Yale Univ. Press. Yale.
8. Young, J.Z. 1981. The life of vertebrates. Butler and Tanner Ltd. Frame, Somerset, UK.
9. Hildebrand, M. and Goslow, G. 2002Analysis of Vertebrate Structure, 5e, Wiley.

Cell Biology

1. Cooper, G. M. 2006. The Cell: A molecular Approach. Sinauer Associates Inc.

2. Lodish H., Berk A., Kaiser C., Krieger, M., Scott, M. P., Bretscher A., Ploegh H. and Matsudaira P. 2007. Molecular Cell Biology: Macmillan education
3. Karp, G. 2008. Cell and Molecular Biology: Concepts and experiments. John Wiley

Molecular Biology and Genetics

1. Russell P. J. 2005. *i*Genetics: A Mendelian approach.
2. Pierce B. A. 2005. Genetics A conceptual Approach. W.H. Freeman and Co.
3. Snustad, D. P. and Simmons, M. J. 2011. Principles of Genetics. John Wiley and Sons
4. Strickberger M.W. 2012. Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Tamarin, R. H. 2004. Principles of Genetics. Tata McGraw-Hill Publishing Comp. Ltd.
6. Kothari, M.L. and Mehta, L.A. Roychoudhuri, S.S. 1999. (impression 2009) Essentials of Human genetics, University Press (India) Pvt. Ltd. Hyderabad
7. Singh, B.D. 2004. Fundamentals of Genetics, Kalyani Publishers, N.Delhi
8. Griffith, J.F., Wessler, S., Doebley, J. and Carroll, S.B. 2010. An introduction to genetic analysis- W H Freeman & Company
9. Klug, W.S., Cummings, M.R., Spenser, C.A. and Palladino, M.A. 2011. Concept of Genetics- Benjamin Cummings.
10. Lewin, B. and Krebs, J.E. 2011. Lewin's Gene X - Jones & Bartlett Learning, LLC.

Laboratory and Analytical Techniques

1. Friefelder, D. 2002. Physical Biochemistry. W. H. Freeman and Co.
2. Wilson, K., and Walker, J. (eds.) 2001. Principles and Techniques of Practical Biochemistry. Cambridge University Press.
3. Sadasivan, S. and Manickam, A. 2003. Biochemcal Methods. New Age International Publishers.
4. Ruxton, G. D. and Colegrave, N. 2006. Experimental Design for Life Sciences - 2e, Oxford University Press.
5. Holmes, D., Moody, P. and Dine, D. 2006. Research Methods for the Biosciences - Oxford University Press.

Biochemistry

1. Nelson, D. L. and Cox. M. M. 2008. Lehninger's Principles of Biochemistry. Macmillan Worth Publishers.
2. Murray R., Bender D., Botham K.M., Kennelly P.J., Rodwell V., Weil P.A. 2012. Harpers illustrated Biochemistry: McGrawHill Education. India
3. Berg, J. M., Tymoczko, J. K. and Stryer, L. 2002. Biochemistry. W. H. Freeman and Company.
4. Das, D. 1980. Biochemistry: Academic Publishers
5. Boyer R. 2000. (5th impression 2009). Modern Experimental Biochemistry, Pearson Education.
6. Elliot, W.H. and Elliot, D.C. 2009. Biochemistry and Molecular biology- Oxford University Press.

Basic Concepts of Immunology

1. Goldsby, R. A., Kindt, T. J., Kuby, J. and Osborne, B. A. 2007. Immunology. W. H. Freeman and Co.
2. Chakraborty, A.K. 2014. Immunology and Immunotechnology: Oxfrod University Press. India
3. Pinchnk, G. 2002. Theory and Problems of Immunology, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

Animal Physiology and Adaptation

1. Hall J.E. 2010. Guyton and Hall Textbook of Medical Physiology. Saunders

2. Barrett K.E., Barman S.M. Boitano S. Brooks, H.L. 2012. Ganong's Review of Medical Physiology. McGraw-Hill Medical
3. Randell, D. Burggren, W. French, K. 1997. Eckert's Animal Physiology: W.H. Freeman & Company, New York
4. Berry, A.K. 1997. A Text book of Animal Physiology, 6e, Emkay Publications, Delhi-51.
5. Schmidt-Nielsen, K. 1997. Animal Physiology: Adaptation and Environment –Camrbdige University Press
6. Chaudhuri, S.K.2002. Concise Medical Physiology (4th ed). New Central Book Agency (P) Ltd.

Endocrinology and Reproductive Biology

1. Hadley, M.E. and Levine J.E. 2009. Endocrinology. Dorling Kindersley (India) Pvt. Ltd. Pearson Education.
2. Bentley, P. J. 1998. Comparative vertebrate endocrinology - CUP.

Histology and Histochemistry

1. Verma, G.P. 2001. Fundamentals of Histology. New Age International (P) Ltd. Publishers
2. Sharma, V.K. 1991. Microscope and cell biology. Tata McGraw Hill Pub. Co. Ltd.
3. Copenhaven, W. M. Bung, R.P. and Bunge, M.B. 1971. Bailey's Text Book of Histology. William and Wilkins Co.

Developmental Biology and Teratology

1. Gillbert, S.F. 2000. Developmental Biology. Sinauer Associates.
2. Wolpert L. and Tickle C. 2011. Principles of Development. Oxford University Press
3. Balinsky, B.I. 2012. An Introduction to Embyology, 5th ed, Cengage Learning.
4. O'Rahilly & Muller; 2001. Human Embryology & Teratology, 3e –Wiley
5. Carlson, B.M. 2014. Human Embryology and Developmental Biology – Elsevier.
6. Slack, J. M. W. 2013. Essential Developmental Biology - Wiley- Blackwell.

Ecology and Environmental Science

1. Sharma, P.D. 1997. Ecology and Environment: Rastogi Publications, Meerut
2. Dash, M. C. 2009. Fundamental of Ecology. Tata McGraw-Hill Company.
3. Stiling, P. 2001. Ecology- Theories and Applications. Prentice Hall of India.
4. Krebs, C.J. 1978. Ecology: The Experimental Analysis of Distribution and Abundance, Harper International Edition.
5. Gaston, K. 1996. Biodiversity, A biology of numbers and difference, Blackwell Science.
6. Santra S. C. 2010. Fundamentals of Ecology and Environmental Biology. New Central Book Agency (P) Ltd.
7. Cunningham, W. and Cunningham, M. 2009. Principles of Environmental Science,5e - TMH.
8. Chatterjee, B. 2007 Environmental Laws - Implementation Problems - Deep & Deep Pubs.
9. Kumar, A. 2004. Textbook of Environmental Science - APH Publishing Co., ND.
10. Hawkins, R. E. 2001, Encyclopedia of Indian Natural History –BNHS/OUP.
11. Primack, R. 2010. Essentials of Conservation Biology - Sinaur Associates
12. Chapman J.L. and Reiss, M. 1998. Ecology: Principles and Applications, 2e - Cambridge Low Price Editions.
13. Ramakrishnan, P.S. 2012. Ecology and Sustainable Development 2nd edition – National Book Trust India- Publication division Govt.of India
14. Smith, R.L. and Smith, T.M. 2001. Ecology and Field Biology: Hands-on Field Package, 6e – Benjamin Cummings

15. Molles, M.C (Jr). 2009. Ecology: Concepts and Application (4th ed). McGraw Hill (International Edition)

Wildlife

1. Kothari, A.S. 2012. Wildlife of the Himalayas and Terai region. Bombay Natural History Society. Central Marketing Dept. Hornbill House. S.B. Singh Marg, Mumbai 400001.
2. Daniel. J.C. 2002. The Book of Indian Reptiles and Amphibians. Bombay Natural History Society. Oxford University Press.
3. Prater, S.H. 1971. The Book of Indian Animals. Bombay National. Oxford University Press.
4. Ali, S. 1996. The book of Indian Birds. Bombay Natural History Society. Oxford University Press.

Toxicology

1. Pandey, K. and Shukla, J.P. 1992. Elements of Toxicology. D.K. Publishers Distributors P Ltd.
2. Subramanian, M.A. 2010. Toxicology- Principles and methods. MJP Publishers.

Biotechnology

1. Singh B.D. 2000. Biotechnology: Kalyani Publiushers, New Delhi
2. Balsubramanian, D. (Ed) 1992. Concept of biotechnology. Oxford Universities Press
3. Kreuzer, H. and Massev, A. 2007. Molecular Biology and Biotechnology- ASM Press
4. Satyanarayana, U. 2008. Biotechnology –Books & Allied (P) Ltd.

Animal Behaviour

1. Alcock, J. 2009. Animal Behaviour: An Evolutionary Approach. Sinauer Associates
2. Drickamer, L.C., Vessey, S. and Jakob, E. 2002. Animal Behaviour: Mechanisms, Ecology, Evolution: McGraw-Hill Education.
3. Manning, A. and Dawkins, M.S. 1998. Essentials of Animal Behaviour. Cambridge Univ. Press.
4. Davies, N.B., Krebs, J.R., and West, S.A. 2012. An Introduction to Behavioural Ecology, 4e – Wiley-Blackwell.
5. Mandal F. B. 2010. Textbook of Animal Behaviour –PHI (EEE)

Bioinformatics:

1. Ghosh, Z. and Mallick, B. 2008. Bioinformatics: Principles and Applications. Oxford University Press. India
2. Rastogi, S.C. and Rastogi. M. P. 2005. Bioinformatics: Method & Applications. Genomics, Proteomiocs & Drug Discovery. Prentice Hall of India, New Delhi.
3. Xiong, J. 2006. Essential Bioinformatics - Cambridge University Press, India Pvt. Ltd.

Biophysics:

1. Daniel, M. 1989. Basic Biophysics for Biologists, Agro Botanical Publishers (India) Bikaner

Economic Zoology

1. David, B.V. and Ananthakrishnan, T.N. 2010. General and Applied Entomology. Tata McGraw Hill Education Pvt. Ltd. N. Delhi
2. Srivastava, K. P. 1996 (reprinted 2004). Applied Entomology vol. I and II. Kalyani Publishers
3. Dey, N.C., Dey, T.K., Dey Sinha, M. 2010. Medical Parasitology. New Central Book Agency (P) Ltd. Kolkata

Practical:

1. Ghosh, K. C. and Manna, B. 2005. Practical Zoology. New Central Book Agency (P) Ltd. Kolkata.
2. Bhattachryya, B.N. 2008. An Introduction to Ornithology and Biology pf the Blue Rock Pigeon, New Central Book Agency (P) ltd. Kolkata-9
3. Poddar, T., Mukhopadhyay, S. Das, S.K. 2003. An advanced Laboratory Manual of Zoology. MacMillan India Limited, Kolkata.
4. Thimmaiah S.K. 1999. Standard Methods of Biochemical Analysis. Kalyani Publishers, New Delhi. Reprinted 2004
5. Negi, K.S. 2006. Biostatistics. A.I.T.B.S. Publishers and Distributors (Regd.)
6. Rajathi, A. and Chandran, P. 2010. SPSS for you. MJP Publishers, Chennai
7. Khandpur, R.S. 2006. Handbook of Analytical Instruments. Tata McGraw-Hill Publishing Company Ltd.
8. Chainy, G.B.N. 2004. Basic Biostatistics, Kalyani Publishers, N. Delhi.

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ZOOLOGY HONOURS

CBCS SYLLABUS

(2018)

1. Introduction

The syllabus for Zoology at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC.
The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Zoology.
Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

There is wide deviation in the infrastructure, be it physical or in human resource, in the form of teachers' expertise and ability and aspiration of the students. Hence, University is free to choose the Electives as per their infrastructural strengths and offer at least 6 to 7 electives
While the syllabus is in compliance with UGC model curriculum, it is necessary that Zoology students should learn "Immunology" as one of the core courses rather than as elective. Also, an important discipline specific elective on "Microbiology" has been added.

Project Work may be introduced instead of the 4th Elective with a credit of 6 split into 2+4, where 2 credits will be for continuous evaluation and 4 credits reserved for the merit of the dissertation.

2. Scheme for CBCS Curriculum

2.1.Credit Distribution across Courses

Course Type	Number of Courses	Credits		
		Theory	Practical	Theory + Practical
Core Courses (CC)	14	14×4 =56	14×2 =28	84
Discipline Specific Electives (DSE)	4	4×4=16	4×2=8	24
Generic Electives (GE)	4	4×4=16	4×2=8	24
Ability Enhancement Compulsory Courses (AECC)	2	2×2=4		4
Skill Enhancement Courses (SEC)	2	2×2=4		4
Totals	26	96	44	140

2.2. Scheme for CBCS Curriculum (Zoology Honours)

YEAR	SEMESTER	CORE COURSE (CC) (14T+14L) (Credit 14x4+ 14x2)	ABILITY ENHANSMENT COMPULSORY COURSE (AECC)(2T) (Credit 2x2)	SKILL ENHANSMENT COMPULSORY COURSE (SEC)(2T) (Credit 2x2)	DISCIPLINE SPECIFIC ELECTIVES (DSE) (4T+4L) (Credit 4x4+ 4x2)	GENERIC ELECTIVES (GE) (4T+4L) (Credit 4x4+ 4x2) (For other Disciplines)	TOTAL CREDITS
1	I	CC-1 NON-CHORDATE I CC-2 ECOLOGY	AECC-1 ENVIRONMENTAL SCIENCE			GE1 PAPER-1 * Gr.A-ANIMAL DIVERSITY Gr. B-INSECT VECTORS Gr.C-AQUATIC BIOLOGY	20
	II	CC-3 NON-CHORDATE II CC-4 CELL BIOLOGY	AECC-2 ENGLISH COMMUNICATION/ MAJOR INDIAN LANGUAGE			GE1 PAPER-2* Gr.A-HUMAN PHYSIOLOGY Gr.B-FOOD NUTRITION & HEALTH Gr.C-ENVIRONMENT AND PUBLIC HEALTH Gr.D-ANIMAL CELL BIOTECHNOLOGY	20
2	III	CC-5 CHORDATES CC-6 ANIMAL PHYSIOLOGY: CONTROLING & COORDINATING SYSTEM CC-7 GENETICS		SEC PAPER-1 * Gr.A-APICULTURE Gr.B-AQUADIUM FISH KEEPING		GE2 PAPER-1 * Gr.A-ANIMAL DIVERSITY Gr. B-INSECT VECTORS Gr.C-AQUATIC BIOLOGY	26
	IV	CC-8 COMPARATIVE ANATOMY OF VERTEBRATES CC-9 ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS CC-10 FUNDAMENTALS OF BIOCHEMISTRY		SEC PAPER- 2 * Gr.A-SERICULTURE Gr.B-MEDICAL DIAGNOSTIC TECHNIQUES		GE2 PAPER-2* Gr.A-HUMAN PHYSIOLOGY Gr.B-FOOD NUTRITION & HEALTH Gr.C-ENVIRONMENT AND PUBLIC HEALTH Gr.D-ANIMAL CELL BIOTECHNOLOGY	26
3	V	CC-11 MOLECULAR BIOLOGY CC-12 IMMUNOLOGY			DSE PAPER-1* Gr.A- REPRODUCTIVE BIOLOGY, Gr. B-ENDOCRINOLOGY DSE PAPER-2 * Gr.A- ANIMAL BEHAVIOUR & CHRONOBIOLOGY Gr.B- WILDLIFE CONSERVATION & MANAGEMENT		24
	VI	CC-13 DEVELOPMENTAL BIOLOGY CC-14 EVOLUTIONARY BIOLOGY AND BIOSTATISTICS			DSE PAPER-3 * Gr.A- MICROBIOLOGY Gr.B-PARASITOLOGY DSE PAPER-4 * Gr.A- ANIMAL BIOTECHNOLOGY Gr.B- FISH & FISHERIES Gr.C- BIOLOGY OF INSECTS		24
TOTAL		**56+28=84**	**4**	**4**	**16+8=24**	**16+8=24**	**140**

*Students have to select any one group for the respective course

2.3. Credit Distribution across Semester

Semester	Course Name	Course Detail	Credits
I	Ability Enhancement Compulsory Course–I	Environmental Science	2
	Core course–I	Non-chordates I	4
	Core course–I Practical	Non-chordates I Lab	2
	Core course–II	Ecology	4
	Core course–II Practical	Ecology Lab	2
	Generic Elective–1 (Paper-1)	Animal diversity / Insect Vectors/Aquatic Biology	4
	Generic Elective–1 (Paper-1) Practical	Animal diversity Lab / Insect Vectors/ Aquatic Biology Lab	2
II	Ability Enhancement Compulsory Course–II	English/ Bengali/ MIL	2
	Core course–III	Non-chordates II	4
	Core course–III Practical	Non-chordates II Lab	2
	Core course–IV	Cell Biology	4
	Core course–IV Practical	Cell Biology Lab	2
	Generic Elective–1 (Paper-2)	Human Physiology/ Food Nutrition & Health/ Environment & Public Health/ Animal Cell Biotechnology	4
	Generic Elective–1 (Paper-2) Practical	Human Physiology/ Food Nutrition & Health/ Environment & Public Health/ Animal Cell Biotechnology Lab	2
III	Core course–V	Chordates	4
	Core course–V Practical	Chordates Lab	2
	Core course–VI	Animal Physiology: Controlling and Coordinating Systems	4
	Core course – VI Practical	Animal Physiology: Controlling and Coordinating Systems Lab	2
	Core course–VII	Genetics	4
	Core course–VII Practical	Genetics Lab	2
	Skill Enhancement Course–Paper1	Aquaculture/ Aquarium Fish Keeping	2
	Generic Elective–2 (Paper-1)	Animal diversity / Insect Vectors/Aquatic Biology	4
	Generic Elective–2 (Paper-1) Practical	Animal diversity / Insect Vectors/Aquatic Biology Lab	2

IV	Core course–VIII	Comparative Anatomy of Vertebrates	4
	Core course–VIII Practical	Comparative Anatomy of Vertebrates Lab	2
	Core course–IX	Animal Physiology: Life Sustaining Systems	4
	Core course–IX Practical	Animal Physiology: Life Sustaining Systems Lab	2
	Core course–X	Fundamentals of Biochemistry	4
	Core course–X Practical	Fundamentals of Biochemistry Lab	2
	Skill Enhancement Course- Paper 2	Sericulture/ Medical Diagnostic Techniques	2
	GenericElective–2 (Paper-2)	Human Physiology/ Food Nutrition & Health/Environment & Public Health/ Animal Cell Biotechnology	4
	Generic Elective–2 (Paper-2) Practical	Human Physiology/ Food Nutrition & Health/ Environment & Public Health/ Animal Cell Biotechnology Lab	2
V	Core course–XI	Molecular Biology	4
	Core course–XI Practical	Molecular Biology Lab	2
	Core course–XII	Immunology	4
	Core course–XII Practical	Immunology Lab	2
	Discipline Specific Elective–Paper 1	Endocrinology /Reproductive Biology	4
	Discipline Specific Elective– Paper 1 Practical	Endocrinology Lab / Reproductive Biology Lab	2
	Discipline Specific Elective–Paper2	Animal Behaviour and Chronobiology/ Wildlife Conservation and Management	4
	Discipline Specific Elective–Paper 2 Practical	Animal Behaviour and Chronobiology /Wildlife Conservation and Management Lab	2
VI	Core course–XIII	Developmental Biology	4
	Core course–XIII Practical	Developmental Biology Lab	2
	Core course–XIV	Evolutionary Biology and Biostatistics	4
	Core course–XIV Practical	Evolutionary Biology and Biostatistics Lab	2
	Discipline Specific Elective–Paper 3	Microbiology/Parasitology	4
	Discipline Specific Elective–Paper 3 Practical	Microbiology Lab/Parasitology Lab	2
	Discipline Specific Elective–Paper 4	Animal Biotechnology/ Fish and Fisheries/Biology of Insects	4
	Discipline Specific Elective- Paper 4 Practical	Animal Biotechnology/ Fish and Fisheries/Biology of Insects Lab	2

SEMESTER-I

1. CC1- Non-Chordates I (THEORY)

Non-Chordates I		
	4 Credits	**Class**
Unit 1: Basics of Animal Classification		4
Definitions: Classification, Systematics and Taxonomy; Levels of Taxonomy: Alpha, Beta & Gamma Taxonomy; Taxonomic Hierarchy, Taxonomic types: Primary, Secondary (Definition) Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy kingdom concept of classification (Whittaker and Carl Woese)		
Unit 2: Protista and Metazoa		15
Protozoa General characteristics and Classification up to phylum (according to Levine et. al., 1981), Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica* **Metazoa** Evolution of symmetry and segmentation of Metazoa		
Unit 3: Porifera		6
General characteristics and Classification up to classes; Cell types, Spicules and Canal system in sponges		
Unit 4: Cnidaria		10
General characteristics and Classification up to classes Metagenesis in *Obelia* Polymorphism in Cnidaria Corals and coral reef diversity, function & conservation		
Unit 5: Ctenophora		2

General characteristics	
Unit 6: Platyhelminthes	6
General characteristics and Classification up to classes Life cycle of *Fasciola hepatica* and *Taenia solium*	
Unit 7: Nematoda	7
General characteristics and Classification up to classes Life cycle, of *Ascaris lumbricoides* and *Wuchereria bancrofti* Parasitic adaptations in helminthes	
Reference Books	
► Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition. ► Invertebrates by Brusca & Brusca. Second edition, 2002.	

Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th Edition.

2. CC1 –Non-Chordates I (Lab)

Non-Chordates I	
	2 credits
List of Practical	
1. Preparation of whole mount of *Euglena*/ *Amoeba* / *Paramoecium* 2. Identification with reasons: *Amoeba*, *Euglena*, Tetranucleate stage of *Entamoeba*, *Opalina*, *Paramecium*, *trophozoite stage/ signet ring stage of Plasmodium* (fromthe prepared slides) 3. Identification with reasons: *Sycon*, Neptune's Cup, *Obelia*, *Physalia*, *Millepora*,*Aurelia*,*Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora* 4. Spot identification of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides* 5. Staining/mounting of any protozoa/helminth from gut of cockroach	

3. CC2 –Ecology (THEORY)

Ecology		
	4 Credits	**Class**
Unit 1: Introduction to Ecology		4
History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors (light and temperature), The Biosphere - Introduction.		
Unit 2: Population		20
Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables (Definitions), survivorship curves, dispersal and dispersion. Exponential and logistic growth, equation and patterns, r and k strategies Population regulation - density-dependent and independent factors Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.		
Unit 3: Community		11
Community characteristics: species diversity, abundance, , dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession with one example		
Unit 4: Ecosystem		10
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Nutrient and biogeochemical cycle with an example of Nitrogen cycle Human modified ecosystem		
Unit 5: Applied Ecology		5
Wildlife Conservation (in-situ and ex-situ conservation). Management strategies for tiger conservation; Wild life protection act (1972)		

Reference Books	
► Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings. ► Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole ► Robert Leo Smith Ecology and field biology Harper and Row publisher ► Ecology: Theories & Application (2001). 4th Edition by Peter Stilling. ► Ecology by Cain, Bowman & Hacker. 3rd edition. Sinauer associates	

4. CC2–Ecology (Lab)

Ecology	
	2 Credits
List of Practical	
1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided 2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community 3. Study of an aquatic ecosystem: zooplankton, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand (Dark bottle method) and free CO_2 4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary	

5. GE 1 PAPER 1 (Group-A) -Animal Diversity (THEORY)

Animal Diversity		
	4 Credits	**Class**
Unit 1: Protista		**3**
Protozoa General characters of Protozoa; Life cycle of *Plasmodium*		
Unit 2: Porifera		3
General characters and canal system in Porifera		
Unit 3: Radiata		3
General characters of Cnidarians and polymorphism		
Unit 4: Aceolomates		2
General characters of Platyhelminthes		
Unit 5: Pseudocoelomates		3
General characters of Nematoda		
Unit 6: Annelida		3
General characters of Annelida Metamerism		
Unit 7: Arthropoda		4
General characters Social life in Honey bees.		
Unit 8: Mollusca		4

General characters of mollusc Pearl Formation	
Unit 9: Echinodermata	4
General characters of Echinodermata Water Vascular system in Starfish	
Unit 10: Protochordata	2
Salient features	
Unit 11: Pisces	3
General Characters Migration of Fish	
Unit 12: Amphibia	4
General characters, Parental care	
Unit 13: Reptilia	4
General Characters, Differences between poisonous and non-poisonous snakes, poison apparatus, venom and anti-venom	
Unit 14: Aves	4
General Characters Flight adaptations	
Unit 15: Mammalia	4
General Characters, Integumentary glands	
Reference Books	
► Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA. ► Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole ► Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.	

- Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
- Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

6. GE 1 PAPER 1 (Group-A) –Animal Diversity (Lab)

Animal Diversity	
	2 Credits

List of Practical

1. Spot identification (specimen/ photographs/ permanent slides):
    a. Non Chordates: *Euglena*, *Paramecium*, *Sycon*, , *Physalia*, *Metridium*, *Taenia*, *Ascaris*, *Nereis*, Leech, *Peripatus*, *Limulus*, Hermitcrab, *Daphnia*, Millipede, Centipede, Beetle, *Chiton*, *Octopus*, *Asterias*, *Antedon* and *Balanoglossus*,
    b. Chordates: *Amphioxus*, *Petromyzon*, Scoliodon, *Hippocampus*, *Labeo*, *Icthyophis*/*Uraeotyphlus*, Salamander, *Draco*, *Naja*, *Viper*, Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.
2. Identification of following specimen through Slides/ photographs:
   Cross section of *Sycon*, and *Ascaris* (male and female). T. S. of Earthworm passing through typhlosolar intestine. Bipinnaria and Pluteus larva.
3. Temporary mounts of:
    a. Cyclophs/ Daphnia.
    b. Unstained mounts of Placoid, cycloid and ctenoid scales.
4. Dissections of:
    a. Digestive system of Cockroach
5. Study of gut parasite of cockroach.

7. GE 1 PAPER 1 (Group-B) -Insect Vectors and Diseases (THEORY)

Insect Vectors and Diseases		
	4 Credits	**Class**
Unit 1: Introduction to Insects		2
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts (with reference to feeding)		
Unit 2: Concept of Vectors		4
Brief introduction to Carriers and Vectors (mechanical and biological vectors),Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity		
Unit 3: Insects as Vectors		6
Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera		
Unit 4: Dipteran as Disease Vectors		20
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes Study of sand fly-borne diseases –Leishmaniasis,(visceral and cutaneous), phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly		
Unit 5: Siphonaptera as Disease Vectors		6
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas		
Unit 6: Siphunculata as Disease Vectors		6
Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse		
Unit 7: Hempitera as Disease Vectors		6

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	
Reference Books	
► Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK ► Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK ► Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication ► Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell ► Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata ► Medical Entomology, Hati A. K Allied Book Agency, Kolkata	

8. GE 1 PAPER 1 (Group-B) –Insect Vectors and Diseases (Lab)

Insect Vectors and Diseases	
	2 Credits
List of Practical	
1. Identification of different kinds of mouth parts of insects (Slides/ photographs) 2. Identification of following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanus capitis*, *Pediculus humanus corporis*, *Phithirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica* 3. Study of different diseases transmitted by above insect vectors 4. Submission of a project report on any one of the insect vectors and disease transmitted	

9 . GE 1 PAPER 1 (Group-C)-Aquatic Biology (THEORY)

Aquatic Biology		
	4 Credits	**Class**
Unit 1: Aquatic Biomes		**10**
Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.		
Unit 2: Freshwater Biology		20
Lakes: Lake as an Ecosystem, 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: Physico-chemical environment, Adaptation of hill- stream fishes.		
Unit 3: Marine Biology		10
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs		
Unit 4: Management of Aquatic Resources		10
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.		
Reference Books		
► Anathakrishnan : Bioresources Ecology 3rd Edition ► Goldman : Limnology, 2nd Edition ► Odum and Barrett : Fundamentals of Ecology, 5th Edition ► Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition ► Wetzel : Limnology, 3rd edition ► Trivedi and Goyal : Chemical and biological methods for water pollution studies ► Welch : Limnology Vols. I-II		

10. GE 1 PAPER 1 (Group-C)–Aquatic Biology (Lab)

Aquatic Biology	
	2 Credits
List of Practical	
1. Determine the area of a pond using graphimetric and gravimetric method. 2. Identification of the important zooplanktons present in a pond ecosystem. 3. Determine the amount of Dissolved Oxygen, and Free Carbon dioxide, Totoal alkalinity (carbonates & bicarbonates) in water collected from a nearby lake / water body. 4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.	

(OUT OF THREE GROUPS OF GE 1 PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-II

11. CC3–Non-Chordates II (THEORY)

Non-Chordates II		
	4 Credits	**Class**
Unit 1: Introduction		2
Evolution of coelom and metamerism		
Unit 2: Annelida		10
General characteristics and Classification up to classes Excretion in Annelida through nephridia, locomotion in *Nereis* Metamerism in Annelida.		
Unit 3:Arthropoda		16
General characteristics and Classification up to classes Vision in Insecta only. Respiration in Arthropoda (Gills in prawn and trachea in cockroach) Metamorphosis in Lepidopteran Insects.		
Unit 4: Onychophora		2
General characteristics and Evolutionary significance; and affinities of *Peripatus.*		
Unit 5: Mollusca		10
General characteristics and Classification up to classes Nervous system and torsion and detorsion in Gastropoda Respiration in *Pila* sp; Evolutionary significance of trochophore larva.		
Unit 6: Echinodermata		8
General characteristics and Classification up to classes Water-vascular system in Echinodermata, Larval forms in Echinodermata, Affinities with Chordates		

Unit 7: Hemichordata	**2**
General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	
Reference Books	
► Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition ► The Invertebrates: A New Synthesis, III Edition, Blackwell Science	

Note: Classification to be followed from Rupert and Barnes, 1994, 6th Edition / Brusca and Brusca 2003.

12. CC 3–Non-Chordates II (Lab)

Non-Chordates II	
	2 Credits
List of Practical	

1. Identification with reasons:
    a. Annelids - *Aphrodite, Nereis/ Heteronereis, Sabella, Chaetopterus, Pheretima, Hirudinaria*
    b. Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees *Onychophora - Peripatus*
    c. Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Sepia, Octopus, Nautilus*
    d. Echinodermates - *Pentaceros/Asterias, Ophiura, Clypeaster (*Sand Dollars*), Echinus, Cucumaria* and *Antedon*
    e. Hemichordates- *Balanoglossus*
2. Study of digestive system, septal nephridia, pharyngeal naphridia of earthworm (chart/model)
3. Identification of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
4. Mounting of mouth parts and dissection of digestive system and nervous system of *Periplaneta*
5. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

13. CC 4 - Cell Biology (THEORY)

Cell Biology		
	4 Credits	**Class**
Unit 1: Overview of Cells		2
Basic structure of Prokaryotic and Eukaryotic cells, Viruses, Viroid, Prion and Mycoplasma		
Unit 2: Plasma Membrane		6
Ultra structure and composition of Plasma membrane: Fluid mosaic model Transport across membrane: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Gap junctions, Desmosomes		
Unit 3: Cytoplasmic organelles I		5
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes Protein sorting and mechanisms of vesicular transport		
Unit 4: Cytoplasmic organelles II		6
Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes: Structure and Functions Centrosome: Structure and Functions		
Unit 5: Cytoskeleton		5
Types and function of cytoskeleton, structure of microtubules and microfilaments Accessory proteins of microfilament & microtubule A brief idea about molecular motors		
Unit 6: Nucleus		8
Structure of Nucleus: Nuclear envelope, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)		

Unit 7: Cell Division	10
Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes). Mitosis and Meiosis: Basic process and their significance	
Unit 8: Cell Signaling	8
Cell signalling transduction pathways; Types of signaling molecules and receptors GPCR and Role of second messenger (cAMP), Protein kinase and Ca^{+2} Apoptosis and Necrosis- brief idea	
Reference Books	
► Lewin's Cells – 3rd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers ► Biology of Cancer by Robert. A. Weinberg. 2nd edition. ► Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA. ► Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.	

14. CC 4–Cell Biology (Lab)

Cell Biology	
	2 Credits
List of Practical	
1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis 2. Study of various stages of meiosis fromgrasshopper testis (Squash preparation) 3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells. 4. Preparation of permanent slide to demonstrate DNA by Feulgen reaction 5. Cell viability study by Trypan Blue staining (use spleen)	

15. GE 1 PAPER 2 (Group- A) -Human Physiology (THEORY)

Human Physiology		
	4 Credits	**Class**
Unit 1: Digestion and Absorption of Food		**8**
Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (in brief)		
Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)		10
Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction		
Unit 3: Respiratory Physiology		6
Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.		
Unit 4: Renal Physiology		6
Functional anatomy of kidney, Mechanism and regulation of urine formation,		
Unit 5: Cardiovascular Physiology		8
Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG		
Unit 6: Endocrine and Reproductive Physiology		12
Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle		
Reference Books		
► Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc. ► Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill. ► Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt		

Asia Pvt. Ltd/ W.B. Saunders Company.

- Marieb, E. (1998). Human Anatomy and Physiology, IV Edition, Addison-Wesley.
- Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers.
- Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics,
- S. Chand and Company Ltd.

16. GE 1 PAPER 2 (Group- A) –Human Physiology (Lab)

Human Physiology	
	2 Credits
List of Practical	

1. Preparation of temporary slides: Neurons /Blood film.
2. ABO blood group typing.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Identification of permanent histological sections of mammalian oesophagus, stomach, duodenum/ileum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

17. GE 1 PAPER 2 (Group- B) -Food, Nutrition and Health (THEORY)

Food, Nutrition and Health		
	4 Credits	**Class**
Unit 1: Basic concept of food and nutrition		**6**
Food Components and food-nutrients Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and lactating mothers, infants, school children, adolescents and elderly		
Unit 2: Nutritional Biochemistry		**16**
Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions		
Unit 3: Health		**14**
Introduction to health- Definition, concept of health and disease Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention Common ailments- cold, cough, and fevers, their causes and treatment		
Unit 4: Food hygiene and Community health		**14**
Potable water- sources and methods of purification at domestic level Food and Water borne infections: Bacterial infection: cholera, typhoid fever, dysentery; Viral infection: hepatitis, poliomyelitis, Protozoan infection: Amoebiasis, Giardiasis; Helminths infection: Taeniasis, Ascariasis, Vector borne diseases: Malaria and Dengue, their transmission, causative agent,		

sources of infection, symptoms and prevention

Brief account of food spoilage: Causes of food spoilage and their preventive measures

Reference Books

- Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
- Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
- Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
- Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
- Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
- Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.
- Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing

18. GE 1 PAPER 2 (Group- B) – Food Nutrition and Health (Lab)

Food Nutrition and Health	
	2 Credits

List of Practical

1. To detect adulteration in Ghee/ Sugars/ Tea leaves/ Turmeric/ milk
2. Gram staining of bacteria.
3.. Study of the stored grain pests (*Sitophilus oryzae*, *Trogoderma granarium)* and mosquito vectors (*Anopheles*, *Culex* and *Aedes*) from slides/ photograph.Identification, habitat and food sources, damage caused and control.
4. Preparation of temporary mounts of the above stored grain pests.
5. Project- Undertake computer aided diet analysis and Anthropometric nutritional assessment for different age groups.

   OR

   Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability and price

   OR

   Study of nutrition labelling on selected foods

19. GE 1 PAPER 2 (Group- C) -Environment and Public Health (THEORY)

Environment and Public Health		
	4 Credits	**Class**
Unit 1: Introduction		**10**
Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Biomagnification.		
Unit 2: Climate Change		**10**
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health		
Unit 3: Pollution		**5**
Air, water, noise pollution sources and effects, Pollution control		
Unit 4: Waste Management Technologies		**15**
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants.		
Unit 5: Diseases		**10**
Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis		
Reference Books		
► Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999. ► Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996. ► Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998. ► Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V. N. University Press, New York, 2003. ► Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.		

20. GE 1 PAPER 2 (Group- C)–Environment and Public Health Lab

Environment and Public Health	
	2 Credits
List of Practical	
1. To determine pH, Cl, Hardness in water samples from different locations 2. Visit to Auto/vehicle (Emission) pollution testing centre.	

21. GE 1 PAPER 2 (Group- D)–-Animal Cell Biotechnology (THEORY)

Animal Cell Biotechnology		
	4 Credits	**Class**
Unit 1: Introduction		2
Concept and Scope of Biotechnology		
Unit 2: Techniques in Gene manipulation		15
Recombinant DNA technology, Isolation of genes, Restriction endonucleases Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, Construction of Genomic libraries and cDNA libraries Transformation techniques: microbial and animals: Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.		
Unit 3: Animal cell Culture		9
Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures. Basic idea of agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: (Sanger method), Polymerase chain reaction, DNA Fingerprinting.		
Unit 4: Fermentation		8
Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized. Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.		
Unit 5: Transgenic Animal Technology		6

Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly.	
Unit 6: Application in Health	6
Development of recombinant Vaccines, Hybridoma technology, Gene Therapy (ADA). Production of recombinant Proteins: Insulin.	
Unit 7: Bio safety Physical and Biological containment	4
Bio safety Physical and Biological containment	
Reference Books	
► Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited. ► Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press. ► P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003). ► B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001). ► T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001). ► Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998). ► Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman &H.H. Zhang, 1997, CRC Press, New York ► Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, ► W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA	

22. GE 1 PAPER 2 (Group- D) –Animal Cell Biotechnology (Lab)

Animal Cell Biotechnology	
	2 Credits
List of Practical	
1. Packing and sterilization of glass and plastic wares etc for cell culture. 2. Preparation of bacterial culture media. 3. Preparation of genomic DNA from E. coli/animals/ human. 4. DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard). 5. Restriction digestion of lambda (λ) DNA using EcoR1/ Hind III. 6. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, (Through photographs)	

(OUT OF FOUR GROUPS OF GE 1 PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-III

23. CC 5 – Chordates (THEORY)

Chordates		
	4 Credits	**Class**
Unit 1: Introduction to Chordates		2
General characteristics and outline classification of Phylum Chordata (upto class level)		
Unit 2: Protochordata		6
General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in *Ascidia*. General organization and Feeding in *Branchiostoma*		
Unit 3: Origin of Chordata		2
Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata		
Unit 4: Agnatha		2
General characteristics and classification of cyclostomes up to order, Metamorphosis in Lamprey, Zoological importance of ammocoete larva		
Unit 5: Pisces		6
General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses Accessory respiratory organ, migration and parental care in fishes Swimbladder in fishes.		
Unit 6: Amphibia		6
General characteristics and classification up to living Orders. Parental care in Amphibia, Metamorphosis in toad, Neoteny and paedogenesis		
Unit 7: Reptilia		8
General characteristics and classification up to living Orders. Poison apparatus and Biting mechanism in poisonous Snakes		

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Unit 8: Aves	8
General characteristics and classification up to Sub-Classes Exoskeleton, migration and double respiration in Birds Principles and aerodynamics of flight	
Unit 9: Mammals	8
General characters and classification up to living orders Affinities of Prototheria Exoskeletal derivatives of mammals Adaptive radiation in mammals with reference to locomotory appendages Echolocation in Micro chiropterans and Cetaceans	
Unit 10: Zoogeography	2
Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of birds and mammals in different realms	
Reference Books	

- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Parker, T. J. &Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
- Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
- Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
- Nelson, J.S., (2006) : Fishes of the World, 4th Edn., Wiley.
- Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
- Jordan, E.L. &Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.

► Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Duellman and Trueb (1986)/ Young (1981).

24. CC 5–Chordates (Lab)

Chordates	
	2 Credits
List of Practical	

Identification with reasons:

1. Protochordata

   Herdmania, *Branchiostoma*
2. Agnatha

   Petromyzon, *Myxine*
3. Fishes

   Scoliodon, *Sphyrna*, *Torpedo*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*/ *Diodon*-, *Anabas*, Flat fish
4. Amphibia

   Necturus, Axolotl,- *Tylototriton, Bufo, Hyla*
5. Reptilia

   Chelone, *Trionyx*,- *Hemidactylus*,- *Varanus*, *Uromastix*, *Chamaeleon*- *Draco*, *Bungarus*,- *Vipera*, *Naja*, *Hydrophis*, - *Crocodylus*.

   Key for Identification of poisonous and non-poisonous snakes
6. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
7. Mounting of pecten from Fowl head
8. Dissection of brain and pituitary of Tilapia/carp.

25. CC 6 - Animal Physiology: Controlling & Coordinating Systems (THEORY)

Animal Physiology: Controlling & Coordinating Systems		
	4 Credits	**Class**
Unit 1: Tissues		4
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue		
Unit 2: Bone and Cartilage		4
Structure and structural types of bones and cartilages, Ossification		
Unit 3: Nervous System		10
Structure and types of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and Neuromuscular junction; Reflex action and its types		
Unit 4: Muscular system		10
Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of skeletal muscle contraction; Characteristics of muscle fibre: muscle twitch, tetanus.		
Unit 5: Reproductive System		6
Histology of testis and ovary Roles of Hormones in Reproduction including placental hormones		
Unit 6: Endocrine System		16
Histology and function of pituitary, thyroid, pancreas and adrenal Classification of hormones; Mechanism of Hormone action Signal transduction pathways for Steroidal, Protein and peptide hormones Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system		

Reference Books	
► Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins. ► Eckert Animal Physiology by David Randall and Warren Burggren. 4th edition. W. H. Freeman.	

26. CC 6–Animal Physiology: Controlling & Coordinating Systems (Lab)

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

27. CC 7 – Genetics (THEORY)

Genetics		
	4 Credits	**Class**
Unit 1: Mendelian Genetics and its Extension		10
Principles of inheritance, Incomplete dominance and co-dominance, Epistasis Multiple alleles, Lethal alleles, Pleiotropy, Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance.		
Unit 2: Linkage, Crossing Over and Chromosomal Mapping		10
Linkage and Crossing Over, molecular mechanism of crossing over (Holliday model), Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence		
Unit 3: Mutations		**10**
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens		
Unit 4: Sex Determination		8
Mechanisms of sex determination in *Drosophila* Sex determination in mammals Dosage compensation in *Drosophila* & Human		
Unit 5: Extra-chromosomal Inheritance		4
Criteria for extra chromosomal inheritance, Antibiotic resistance in *Chlamyadomonas*, Kappa particle in *Paramoecium* Shell spiralling in snail		
Unit 6: Recombination in Bacteria and Viruses		6
Conjugation, Transformation, Transduction, Complementation test in Bacteriophage		

Reference Books	
► Developmental biology by Scott. F. Gilbert, 9th edition. ► Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc ► Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings ► Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings ► Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.	

28. CC 7–Genetics (Lab)

Genetics	
	2 Credits
List of Practical	
1. Chi-square analyses 2. Linkage maps based on conjugation 3. Identification of chromosomal aberration in *Drosophila* and man from photograph 4. Pedigree analysis of some human inherited traits	

29. SEC Paper 1 (Group-A) –Apiculture (THEORY)

Apiculture		
	2 Credits	**Class**
Unit 1: Biology of Bees		**2**
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		5
Bee Diseases and Enemies Control and Preventive measures		
Unit 4: Bee Economy		2
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc		
Unit 5: Entrepreneurship in Apiculture		6
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens		
Reference Books		
► 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.		

30. SEC Paper 1 (Group-B)-Aquarium Fish Keeping (THEORY)

Aquarium Fish Keeping		
	2 Credits	**Class**
Unit 1: Introduction to Aquarium Fish Keeping		**2**
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 such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish		
Unit 3: Food and feeding of Aquarium fishes		7
Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator		
Unit 4: Fish Transportation		3
Live fish transport - Fish handling, packing and forwarding techniques.		
Unit 5: Maintenance of Aquarium		3
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry		

Reference Books:

- Anshuman D. Dholakia. 2016. Ornamental Fish Culture and Aquarium Management. Astral International.
- Harishanker J. Alappat;A. 2011. Biju Kumar. Aquarium Fishes: A Colourful Profile. BR Publishing Corporation
- Sarij K. Swain, N. Sarangi and S. Ayyappan. 2010. Ornamental Fish Farming. Indian Council of Agricultural Research.

(OUT OF TWO GROUPS OF SEC PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

31. GE 2 PAPER 1 (Group-A) -Animal Diversity (THEORY)

Animal Diversity		
	4 Credits	**Class**
Unit 1: Protista		**3**
Protozoa General characters of Protozoa; Life cycle of *Plasmodium*		
Unit 2: Porifera		3
General characters and canal system in Porifera		
Unit 3: Radiata		3
General characters of Cnidarians and polymorphism		
Unit 4: Aceolomates		2
General characters of Platyhelminthes		
Unit 5: Pseudocoelomates		3
General characters of Nematoda		
Unit 6: Annelida		3
General characters of Annelida Metamerism		
Unit 7: Arthropoda		4
General characters Social life in Honey bees.		
Unit 8: Mollusca		4

General characters of mollusc Pearl Formation	
Unit 9: Echinodermata	4
General characters of Echinodermata Water Vascular system in Starfish	
Unit 10: Protochordata	2
Salient features	
Unit 11: Pisces	3
General Characters Migration of Fish	
Unit 12: Amphibia	4
General characters, Parental care	
Unit 13: Reptilia	4
General Characters, Differences between poisonous and non-poisonous snakes, poison apparatus, venom and anti-venom	
Unit 14: Aves	4
General Characters Flight adaptations	
Unit 15: Mammalia	4
General Characters, Integumentary glands	
Reference Books	
► Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA. ► Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole ► Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.	

- Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
- Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

32. GE 2 PAPER 1 (Group-A) –Animal Diversity (Lab)

Animal Diversity	
	2 Credits

List of Practical

1. Spot identification (specimen/ photographs/ permanent slides):
    a. Non Chordates: *Euglena*, *Paramecium*, *Sycon*, , *Physalia*, *Metridium*, *Taenia*, *Ascaris*, *Nereis*, Leech, *Peripatus*, *Limulus*, Hermitcrab, *Daphnia*, Millipede, Centipede, Beetle, *Chiton*, *Octopus*, *Asterias*, *Antedon* and *Balanoglossus*,
    b. Chordates: *Amphioxus*, *Petromyzon*, Scoliodon, *Hippocampus*, *Labeo*, *Icthyophis*/*Uraeotyphlus*, Salamander, *Draco*, *Naja*, *Viper*, Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.
2. Identification of following specimen through Slides/ photographs:
   Cross section of *Sycon*, and *Ascaris* (male and female). T. S. of Earthworm passing through typhlosolar intestine. Bipinnaria and Pluteus larva.
3. Temporary mounts of:
    a. Cyclophs/ Daphnia.
    b. Unstained mounts of Placoid, cycloid and ctenoid scales.
4. Dissections of:
    a. Digestive system of Cockroach
5. Study of gut parasite of cockroach.

33. GE 2 PAPER 1 (Group-B) -Insect Vectors and Diseases (THEORY)

Insect Vectors and Diseases		
	4 Credits	**Class**
Unit 1: Introduction to Insects		2
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts (with reference to feeding)		
Unit 2: Concept of Vectors		4
Brief introduction to Carriers and Vectors (mechanical and biological vectors),Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity		
Unit 3: Insects as Vectors		6
Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera		
Unit 4: Dipteran as Disease Vectors		20
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes Study of sand fly-borne diseases –Leishmaniasis,(visceral and cutaneous), phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly		
Unit 5: Siphonaptera as Disease Vectors		6
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas		
Unit 6: Siphunculata as Disease Vectors		6
Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse		
Unit 7: Hempitera as Disease Vectors		6

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	
Reference Books	
► Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK ► Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK ► Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication ► Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell ► Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata ► Medical Entomology, Hati A. K Allied Book Agency, Kolkata	

34. GE 2 PAPER 1 (Group-B) –Insect Vectors and Diseases (Lab)

Insect Vectors and Diseases	
	2 Credits
List of Practical	
1. Identification of different kinds of mouth parts of insects (Slides/ photographs) 2. Identification of following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanus capitis*, *Pediculus humanus corporis*, *Phithirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica* 3. Study of different diseases transmitted by above insect vectors 4. Submission of a project report on any one of the insect vectors and disease transmitted	

35. GE 2 PAPER 1 (Group-C)-Aquatic Biology (THEORY)

Aquatic Biology		
	4 Credits	**Class**
Unit 1: Aquatic Biomes		**10**
Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.		
Unit 2: Freshwater Biology		20
Lakes: Lake as an Ecosystem, 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: Physico-chemical environment, Adaptation of hill- stream fishes.		
Unit 3: Marine Biology		10
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs		
Unit 4: Management of Aquatic Resources		10
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.		
Reference Books		
► Anathakrishnan : Bioresources Ecology 3rd Edition ► Goldman : Limnology, 2nd Edition ► Odum and Barrett : Fundamentals of Ecology, 5th Edition ► Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition ► Wetzel : Limnology, 3rd edition ► Trivedi and Goyal : Chemical and biological methods for water pollution studies ► Welch : Limnology Vols. I-II		

36. GE 2 PAPER 1 (Group-C)–Aquatic Biology (Lab)

Aquatic Biology	
	2 Credits
List of Practical	
1. Determine the area of a pond using graphimetric and gravimetric method. 2. Identification of the important zooplanktons present in a pond ecosystem. 3. Determine the amount of Dissolved Oxygen, and Free Carbon dioxide, Totoal alkalinity (carbonates & bicarbonates) in water collected from a nearby lake / water body. 4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.	

(OUT OF THREE GROUPS OF GE 1 PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-IV

37. CC 8 -Comparative Anatomy of Vertebrates (THEORY)

Comparative Anatomy of Vertebrates		
	4 Credits	**Class**
Unit 1: Integumentary System		6
Structure, function and derivatives of integument in birds and mammals		
Unit 2: Skeletal System		6
Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.		
Unit 3: Digestive System		8
Comparative anatomy of stomach in birds and mammals; dentition in mammals		
Unit 4: Respiratory System		6
Respiratory organs in fish, amphibian, birds and mammals		
Unit 5: Circulatory System		8
General plan of circulation, Comparative account of heart and aortic arches		
Unit 6: Urinogenital System		6
Succession of kidney, Evolution of urinogenital ducts		
Unit 7: Nervous System		6
Comparative account of brain, Cranial nerves in mammals		
Unit 8: Sense Organs		4
Classification of receptors		
Reference Books		
► Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education		

- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
- Saxena, R.K. &Saxena, S.C.(2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

38. CC8–Comparative Anatomy of Vertebrates (Lab)

Comparative Anatomy of Vertebrates	
	2 Credits
List of Practical	
1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs 2. Study of disarticulated skeleton of Toad, Pigeon and Guineapig 3. Identification of skulls: *Trionix*, *Calotes*, Guineapig and Dog 4. Dissection of Tilapia/ Carp/ Rat: Circulatory system, Origin and distribution of 9^{th} and 10^{th} cranial nerve	

39. CC 9 - Animal Physiology: Life Sustaining Systems (THEORY)

Animal Physiology: Life Sustaining Systems		
	4 Credits	**Class**
Unit 1: Physiology of Digestion		12
Structural organisation and functions of Gastrointestinal tract and Associated glands; Mechanical and chemical digestion and absorption of Carbohydrates, Lipids, and Proteins ; Digestive enzymes		
Unit 2: Physiology of Respiration		10
Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, types of respiratory pigments; Carbon monoxide poisoning		
Unit 3: Physiology of Circulation		12
Components of Blood and their functions; Structure and functions of haemoglobin Haemostasis; Blood clotting system, Fibrinolytic system Haemopoiesis; Basic steps and its regulation Blood groups; ABO and Rh factor		
Unit 4: Physiology of Heart		**8**
Structure of mammalian heart with special reference to human, Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses Cardiac Cycle and cardiac output Blood pressure and its regulation		
Unit 5: Thermoregulation & Osmoregulation		
Physiological classification based on thermal biology. Thermal biology of endotherms Osmoregulation in aquatic vertebrates		

Extrarenal osmoregulatory organs in vertebrates	
Unit 6: Renal Physiology	8
Structure of Kidney and its functional unit, Mechanism of urine formation, counter current mechanism for formation of concentrated urine, Regulation of acid-base balance	
Reference Books	
► Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company. ► Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons, ► Eckert Animal Physiology: Mechanisms and adaptations Randall, Burggren and FrenchVander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills ► Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins. ► Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills	

40. CC 9–Animal Physiology: Life Sustaining Systems (Lab)

Animal Physiology: Life Sustaining Systems	
	2 Credits
List of Practical	
1. Determination of ABO Blood group and Rh factor 2. Enumeration of red blood cells and white blood cells using haemocytometer 3. Estimation of haemoglobin using Sahli's haemoglobinometer 4. Preparation of haemin and haemochromogen crystals 5. Recording of blood pressure using a sphygmomanometer	

41. CC 10 - Fundamentals of Biochemistry (THEORY)

Fundamentals of Biochemistry		
	4 Credits	**Class**
Unit 1: Carbohydrates		8
Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis		
Unit 2: Lipids		7
Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids. Lipid metabolism: definition of alpha and omega oxidation; β-oxidation of saturated and even carbon-chain fatty acids; Fatty acid biosynthesis		
Unit 3: Proteins		10
Amino acids Structure, Classification, General and Electro chemical properties of α-amino acids; Proteins Bonds stabilizing protein structure; Levels of organization: primary, secondary, tertiary, quaternary, Ramachandran plot Protein metabolism: Transamination, Deamination,, Urea cycle,		
Unit 4: Nucleic Acids		10
Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA		
Unit 5: Enzymes		13
Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot;		

Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition (competitive, uncompetitive, noncompetitive); Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)	
Unit 5: Oxidative Phosphorylation Redox systems; Review of mitochondrial respiratory chain, ATP synthesis, Inhibitors and un-couplers of Electron Transport System	**2**
Reference Books	
► Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York. ► Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York. ► Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc. ► Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K. ► Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.	

42. CC10 –Fundamentals of Biochemistry (Lab)

Fundamentals of Biochemistry	
	2 Credits
List of Practical	
1. Qualitative tests of functional groups in carbohydrates (Molisch's Test, Iodine test, Fehling's Test/ Benedict's Test,Barfoed's Test,Seliwanoff's Test), proteins (Biuret test,Millon's test) and lipids (safonification). 2. Paper & TLC chromatography of amino acids. 3. Quantitative estimation of proteins Lowry Method 4. Demonstration of proteins separation by SDS-PAGE 5. To study the enzymatic activity of salivary amylase	

43. SEC Paper 2 (Group A)– Sericulture (THEORY)

Sericulture		
	2 Credits	**Class**
Unit 1: Introduction		**2**
Sericulture: Definition, Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
Unit 2: Biology of Silkworm		4
Life cycle of *Bombyx mori* Structure of silk gland and secretion of silk		
Unit 3: Rearing of Silkworms		10
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages Spinning, harvesting and storage of cocoons		
Unit 4: Pests and Diseases		7
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases		
Unit 5: Entrepreneurship in Sericulture		2
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture		

Reference Books

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore.
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986
- Jaiswal, K., Trivedi, S. P., Pandey, B.N. and Pandey, P.N. 2009 Indian Sericulture: Past, Present And Future, Alfa Publication.
- Ganga, G. and Sulochana Chetty, J. 2014. Introduction To Sericulture, Oxford & Ibh Publishing Co Pvt Ltd.
- Tripathi, A.K., Pandey, B.N., Jaiswal, K.,. Trivedi, S. P. 2009. Mulberry Sericulture: Problems and Prospects, Aph Publishing Corporation.

44. SEC Ppaer 2 (Group B)– MEDICAL DIAGNOSTIC TECHNIQUES (THEORY)

Medical Diagnostic Techniques		
	2 Credits	**Class**
Unit 1: Introduction to Medical Diagnostics and its Importance		**2**
Unit 2: Diagnostics Methods Used for Analysis of Blood		7
Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)		
Unit 3: Diagnostic Methods Used for Urine Analysis		4
Urine Analysis: Physical characteristics; Abnormal constituents		
Unit 4: Non-infectious Diseases		5
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit (Principle)		
Unit 5: Infectious Diseases		3
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)		
Unit 6: Clinical Biochemistry		1
LFT, Lipid profiling		
Unit 7: Clinical Microbiology		1
Antibiotic Sensitivity Test		
Unit 8: Tumours		2
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).		

Reference Books

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

(OUT OF TWO GROUPS OF SEC PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

45. GE 2 PAPER 2 (Group- A) -Human Physiology (THEORY)

Human Physiology		
	4 Credits	**Class**
Unit 1: Digestion and Absorption of Food		**8**
Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (in brief)		
Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)		10
Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction		
Unit 3: Respiratory Physiology		6
Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.		
Unit 4: Renal Physiology		6
Functional anatomy of kidney, Mechanism and regulation of urine formation,		
Unit 5: Cardiovascular Physiology		8
Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG		
Unit 6: Endocrine and Reproductive Physiology		12
Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle		
Reference Books		
► Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc. ► Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill. ► Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt		

Asia Pvt. Ltd/ W.B. Saunders Company.

- Marieb, E. (1998). Human Anatomy and Physiology, IV Edition, Addison-Wesley.
- Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers.
- Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics,
- S. Chand and Company Ltd.

46. GE 2 PAPER 2 (Group- A) –Human Physiology (Lab)

Human Physiology	
	2 Credits
List of Practical	

1. Preparation of temporary slides: Neurons /Blood film.
2. ABO blood group typing.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Identification of permanent histological sections of mammalian oesophagus, stomach, duodenum/ileum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

47. GE 2 PAPER 2 (Group- B) -Food, Nutrition and Health (THEORY)

Food, Nutrition and Health		
	4 Credits	**Class**
Unit 1: Basic concept of food and nutrition		**6**
Food Components and food-nutrients Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and lactating mothers, infants, school children, adolescents and elderly		
Unit 2: Nutritional Biochemistry		**16**
Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions		
Unit 3: Health		**14**
Introduction to health- Definition, concept of health and disease Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention Common ailments- cold, cough, and fevers, their causes and treatment		
Unit 4: Food hygiene and Community health		**14**
Potable water- sources and methods of purification at domestic level Food and Water borne infections: Bacterial infection: cholera, typhoid fever, dysentery; Viral infection: hepatitis, poliomyelitis, Protozoan infection: Amoebiasis, Giardiasis; Helminths infection: Taeniasis, Ascariasis, Vector borne diseases: Malaria and Dengue, their transmission, causative agent,		

sources of infection, symptoms and prevention

Brief account of food spoilage: Causes of food spoilage and their preventive measures

Reference Books

- Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
- Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
- Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
- Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
- Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
- Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.
- Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing

48. GE 2 PAPER 2 (Group- B) – Food Nutrition and Health (Lab)

Food Nutrition and Health	
	2 Credits

List of Practical

1. To detect adulteration in Ghee/ Sugars/ Tea leaves/ Turmeric/ milk
2. Gram staining of bacteria.
3.. Study of the stored grain pests (*Sitophilus oryzae*, *Trogoderma granarium)* and mosquito vectors (*Anopheles*, *Culex* and *Aedes*) from slides/ photograph.Identification, habitat and food sources, damage caused and control.
4. Preparation of temporary mounts of the above stored grain pests.
5. Project- Undertake computer aided diet analysis and Anthropometric nutritional assessment for different age groups.

   OR

   Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability and price

   OR

   Study of nutrition labelling on selected foods

49. GE 2 PAPER 2 (Group- C) -Environment and Public Health (THEORY)

Environment and Public Health		
	4 Credits	**Class**
Unit 1: Introduction		**10**
Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Biomagnification.		
Unit 2: Climate Change		**10**
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health		
Unit 3: Pollution		**5**
Air, water, noise pollution sources and effects, Pollution control		
Unit 4: Waste Management Technologies		**15**
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants.		
Unit 5: Diseases		**10**
Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis		
Reference Books		
► Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999. ► Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996. ► Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998. ► Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V. N. University Press, New York, 2003. ► Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.		

50. GE 2 PAPER 2 (Group- C)–Environment and Public Health Lab

Environment and Public Health	
	2 Credits
List of Practical	
1. To determine pH, Cl, Hardness in water samples from different locations 2. Visit to Auto/vehicle (Emission) pollution testing centre.	

51. GE 2 PAPER 2 (Group- D)–-Animal Cell Biotechnology (THEORY)

Animal Cell Biotechnology		
	4 Credits	**Class**
Unit 1: Introduction		2
Concept and Scope of Biotechnology		
Unit 2: Techniques in Gene manipulation		15
Recombinant DNA technology, Isolation of genes, Restriction endonucleases Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, Construction of Genomic libraries and cDNA libraries Transformation techniques: microbial and animals: Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.		
Unit 3: Animal cell Culture		9
Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures. Basic idea of agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: (Sanger method), Polymerase chain reaction, DNA Fingerprinting.		
Unit 4: Fermentation		8
Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized. Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.		
Unit 5: Transgenic Animal Technology		

Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly.	
Unit 6: Application in Health	6
Development of recombinant Vaccines, Hybridoma technology, Gene Therapy (ADA). Production of recombinant Proteins: Insulin.	
Unit 7: Bio safety Physical and Biological containment	4
Bio safety Physical and Biological containment	
Reference Books	
► Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited. ► Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press. ► P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003). ► B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001). ► T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001). ► Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998). ► Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman &H.H. Zhang, 1997, CRC Press, New York ► Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, ► W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA	

52. GE 2 PAPER 2 (Group- D) –Animal Cell Biotechnology (Lab)

Animal Cell Biotechnology	
	2 Credits
List of Practical	
1. Packing and sterilization of glass and plastic wares etc for cell culture. 2. Preparation of bacterial culture media. 3. Preparation of genomic DNA from E. coli/animals/ human. 4. DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard). 5. Restriction digestion of lambda (λ) DNA using EcoR1/ Hind III. 6. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, (Through photographs)	

(OUT OF FOUR GROUPS OF GE 2 PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

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53. CC 11 - Molecular Biology (THEORY)

Molecular Biology		
	4 Credits	**Class**
Unit 1: Nucleic Acids		5
Salient features of DNA and RNA Watson and Crick Model of DNA, Clover leaf model of tRNA		
Unit 2: DNA Replication		10
Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous ReplicationRNA priming, Inhibitors of replication		
Unit 3: Transcription		**10**
Mechanism of Transcription in prokaryotes Inhibitors of transcription		
Unit 4: Translation		**12**
Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis		
Unit 5: Gene Regulation		**4**
Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon;		

Unit 6: DNA Repair Mechanisms	4
Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair	
Unit 7: Molecular Techniques	**5**
Basic Principles of PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing	
Reference Books	
► Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman. ► Molecular Biology of The Gene by Watson. 7th Edition. Pearson. ► iGenetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.	

54. CC 11–Molecular Biology (Lab)

Molecular Biology	
	2 Credits
List of Practical	
1. Demonstration of polytene and lampbrush chromosome from photograph 2. Isolation (NaCL-SSC method) and quantification of genomic DNA using spectrophotometer (A260 measurement)/ cholorimeter (diphenylamine method) 3. Agarose gel electrophoresis for DNA (demonstration)	

55. CC 12 – Immunology (THEORY)

Immunology		
	4 Credits	**Class**
Unit 1: Overview of Immune System		2
Basic concepts of health and diseases, Historical perspective of Immunology, Cells and organs of the Immune system		
Unit 2: Innate and Adaptive Immunity		12
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral). Structure of B and T cell Receptor and its signalling, T cell development & selection		
Unit 3: Antigens		4
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes		
Unit 4: Immunoglobulins		8
Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production		
Unit 5: Major Histocompatibility Complex		2
Structure and functions of MHC molecules.		
Unit 6: Cytokines		2
Types, properties and functions of cytokines.		
Unit 7: Complement System		6
Components and pathways of complement activation (Classical & alternative).		
Unit 8: Hypersensitivity		4

Gell and Coombs' classification and brief description of various types of hypersensitivities.	
Unit 9: Immunology of disease	6
Malaria	
Unit 10: Vaccines	4
Various types of vaccines. Active & passive immunization (Artificial and natural).	
Reference Books	

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.
- Ashim Kumar Chakraborty (2005). Immunology and Immunotechnology. Oxford University Press
- Delves, Peter J.; Martin, Seamus J.; Burton, Dennis R.; Roitt, Ivan M. (2011). Roitt's Essential Immunology. Hoboken, NJ: Wiley-Blackwell
- David Male Jonathan Brostoff David Roth Ivan Roitt (2012). Immunology 8th Edition, Elsevier

56. CC 12–Immunology (Lab)

Immunology	
	2 Credits
List of Practical	

1. Demonstration of lymphoid organs.
2. Identification of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of leukocytes
4. Lymphocyte separation from spleen..
5. Demonstration of ELISA

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57. DSE Paper 1 (Group A) -Reproductive Biology (THEORY)

Reproductive Biology		
	4 Credits	**Class**
Unit 1: Reproductive Endocrinology		**10**
Gonadal Hormones, Mechanism of action of steroids and glycoprotein hormones. hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female) Reproductive system: Development and differentiation of gonads, genital ducts		
Unit 2: Functional anatomy of male reproduction		14
Histoarchitechture of testis in human; Spermatogenesis; Hormonal regulation; Androgen synthesis; Accessory glands functions		
Unit 3: Functional anatomy of female reproduction		18
Histoarchitechture of ovary in human; Oogenesis; Hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation		
Unit 4: Reproductive Health		8
Infertility in male and female: causes, diagnosis and management Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, IUI, ICSI Modern contraceptive technologies		
Reference Books		
► Ross & Pawlina. Histology: A text and Atlas. 6th edition. ► Guyton & Hall. Medical Physiology. 11th edition. ► Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd. ► Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.		

58. DSE Paper 1 (Group A) -– Reproductive Biology (Lab)

Reproductive Biology	
	2 Credits
List of Practicals	
1. Visit to animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals. 2. Examination of vaginal smear from liverat . 3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland 4. Identification of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina. 5. Demonstration of Sperm count and sperm motility in rat	

59. DSE Paper 1 (Group B) –Endocrinology (THEORY)

Endocrinology		
	4 Credits	**Class**
Unit 1: Introduction to Endocrinology		4
General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones		
Unit 2: Epiphysis, Hypothalamo-hypophysial Axis		16
Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland.		
Unit 3: Peripheral Endocrine Glands		16
Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis Hormones in Calcium and glucose homeostasis, Disorders of endocrine glands		
Unit 4: Regulation of Hormone Action		14
Mechanism of action of steroidal, non-steroidal hormones with receptors Bioassays of hormones using RIA & ELISA Estrous cycle in rat and menstrual cycle in human Multifaceted role of Vasopressin & Oxytocin. Hormonal regulation of parturition.		
Reference Books		
► Guyton and Hall. Textbook of Medical Physiology. 13th Edition ► Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins. ► Vertebrate Endocrinology by David O. Norris,		

60. DSE Paper 1 (Group B) -–Endocrinology Lab

Endocrinology	
	2 Credits
List of Practical	
1. Dissect and display of Endocrine glands in laboratory bred rat. 2. Identification of the permanent slides of all the endocrine glands 3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland 4. Estimation of plasma level of any hormone using ELISA (Demonstration)	

(OUT OF TWO GROUPS OF DSE PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

61. DSE Paper 2 (Group A) -Animal Behaviour and Chronobiology (THEORY)

Animal Behaviour and Chronobiology		
	4 Credits	**Class**
Unit 1: Introduction to Animal Behaviour		5
Origin and history of Ethology, Brief contributions of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour, Methods and recording of a behaviour		
Unit 2: Patterns of Behaviour		6
Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.		
Unit 3: Social and Sexual Behaviour		15
Social Behaviour: Concept of Society; Communication: Chemical communications in insects and the senses Altruism; Reciprocal altruism and Kin selection Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.		
Unit 4: Introduction to Chronobiology		10
Brief historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period Adaptive significance of biological clocks		
Unit 5: Biological Rhythm		14
Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.		
Reference Books		

- Animal Behaviour by Drickamar.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

62. DSE Paper 2 (Group A) –Animal Behaviour and Chronobiology (Lab)

Animal Behaviour and Chronobiology	
	2 Credits
List of Practical	

1. To study the aggressive behavior of fish..
2. To study the learning behavior of rat,
3. To study geotaxis behaviour in soil arthropod.
4. To study the phototaxis behaviour in soil arthropod/insect larvae .
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/ Zoological Park to study behavioural activities of animals and prepare a short report.

63. DSE Paper 2 (Group B) – Wild Life Conservation and Management (THEORY)

Wild Life Conservation and Management		
	4 Credits	**Class**
Unit 1: Introduction to Wild Life		6
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		8
Habitat analysis, Physical parameters: Topography, Geology, Soil and water Biological Parameters: food, cover, forage, browse and cover estimation Standard evaluation procedures: remote sensing and GIS.		
Unit 3: Management of habitats		6
Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity Restoration of degraded habitats		
Unit 4: Population estimation		12
Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Pug marks and census method.		
Unit 5: Aims and objectives of wildlife conservation		6
Wildlife conservation in India – through ages; different approaches of wildlife conservation; modes of conservation; in-situ conservation and ex-situ conservation: necessity for wildlife conservation		
Unit 6: Management planning of wild life in protected areas		5
Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbence.		
Unit 7: Man and Wildlife		3

Causes and consequences of human-wildlife conflicts; mitigation of conflict – an overview; Management of excess population	
Unit 8: Protected areas	4
National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.	
Reference Books	
► Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science. ► Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University. ► Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press. ► Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences ► 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.	

64. DSE Paper 2 (Group B) –Wild Life Conservation and Management (Lab)

Wild Life Conservation and Management	
	2 Credits
List of Practical	
1. Identification of mammalian fauna/ avian fauna, herpeto-fauna of any protected area of North Bengal. 2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 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. Demonstration of different field techniques for fauna 5. PCQ, ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment. 6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)	

(OUT OF TWO GROUPS OF DSE PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-VI

65. CC 13 - Developmental Biology (THEORY)

Developmental Biology		
	4 Credits	**Class**
Unit 1: Introduction		2
Basic concepts: Phases of Development, Cell cell interaction, Differentiation and growth, Differential gene expression		
Unit 2: Early Embryonic Development		20
Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External (Sea urchin) and Internal (mammal)): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers		
Unit 3: Late Embryonic Development		8
Fate of Germ Layers; Extra-embryonic membranes in chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)		
Unit 4: Post Embryonic Development		12
Development of brain and Eye in chick Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)		
Unit 5: Implications of Developmental Biology		8
Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis		
Reference Books		
► Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA ► Slack JMW , Essential Developmental Biology		

66. CC 13–Developmental Biology (Lab)

Developmental Biology	
	2 Credits
List of Practical	
1. Preparation of whole mount of different developmental stages of chick 2. Identification of whole mounts of developmental stages of chick through permanent slides: 24, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages) 3. Study of the developmental stages and life cycle of *Drosophila* from stock culture 4. Demonstration of male gametes of rat. 5. Project report on Drosophila culture/chick embryo development	

67. CC 14–Evolutionary Biology & Biostatistics (THEORY)

Evolutionary Biology		
	4 Credits	**Class**
Unit 1		**5**
Origin of life, RNA world		
Unit 2		5
Historical review of Evolutionary concepts, Lamarkism, Darwinism and Neo Darwinism		
Unit 3		6
Geological time scale, Evolution of horse, Phylogenetic trees and their interpretations, convergent and divergent evolution Neutral theory of molecular evolution, Molecular clock		
Unit 4		5
Sources of variations: Heritable variations and their role in evolution		
Unit 5		12
Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority). Genetic Drift mechanism (founder's effect, bottleneck phenomenon) Role of Migration and Mutation in changing allele frequencies.		
Unit 6		6
Species concept, Isolating mechanisms, modes of speciation Adaptive radiation/macroevolution (exemplified by Galapagos finches)		

Unit 7	2
Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction	
Unit 8 Biostatistics	9
Central tendencies, Measures of dispersion (Variance, Standard daviation, Standard error) Correlation and regression, T test	
Reference Books	
► Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings. ► Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates. ► iGeneics: A Molecular Approach. 3rd edition. Peter. J. Russell.	
► Robert R. Sokal , F. James Rohlf. 2009. Introduction to Biostatistics: Second Edition. Dover Publications Inc ► Pranab kumar Banerjee. 2011. Introduction to Biostatistics (A Test Book of Biometry). S. Chand & Company Ltd. ► K. S. Negi. 2002. Biostatistics. AITBS publishers, New Dilhi.	

68. CC 14–Evolutionary Biology and Biostatistics (Lab)

Evolutionary Biology	
	2 Credits
List of Practical	
1. Study of vertebrate fossils from models/ pictures (upto class) 2. Study of homology and analogy from suitable specimens /Photographs/ models 3. Study and verification of Hardy-Weinberg Law by chi square analysis 4. Graphical representation and interpretation (correlation and regression) of data of height/ weight of a sample of 100 humans in relation to their age and sex,	

69. DSE Paper 3 (Group A)- Microbiology (THEORY)

Microbiology		
	6 Credits	**Class**
Unit 1: Introduction to Microbiology		4
Historical perspective of Microbiology, Prokaryotic pathogens, Eukaryotic pathogens		
Unit 2: Bacterial taxonomy		4
Principles and modern approaches of bacterial taxonomy. Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woose		
Unit 3: Morphology of Bacteria and Virus		14
Cell wall (Structure of peptidoglycan), Cell envelope (Cell membrane, Differences between gram-positive and gram-negative species, External capsule and glycocalyx, Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Reserve materials (carbon and phosphate reserve, cyanophycin), Cytoplasmic inclusions (Chlorosome, magnetosome, carboxysome, gas vesicles, ribosome). Structural organization of viruses, Prions and viroids		
Unit 4: Normal flora		4
Distribution of normal flora in the body: Skin, eye, mouth, intestinal tract, urino-genital tract, Beneficial functions of normal flora. Harmful effects of normal flora		
Unit 5: Pathogenicity of Microorganisms		10
Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness, Bacterial toxins : Exotoxins, Endotoxins, Antigenic switching.Viral Pathogenesis:Cellular level (Cell death, Transformation, Cell fusion, Cytopathic effect).Initial infections: Routes of entry and dissemination to secondary sites, Typical secondary sites of localization, Virus shedding and mode of transmission; Factors involved in termination of acute infection		
Unit 6: Infection of pathogens to human populations		2
Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic		

Unit 7: Diagnostic Microbiology and Bacteria culture	4
Koch's postulates, Sensitivity and specificity of test results, Principles and applications: Simple staining, Gram-staining, Acid-fast staining, Collection of specimens, Growth requirements and Growth factors, Oxygen requirement. Culture Media: Simple media, Complex media, Selective media and Enriched media	
Unit 8: Genetic recombination in bacteria	4
Transformation, Conjugation- F+, F-, Hfr & F' strain, Transduction, Generalised & specialized types.	
Unit 9: Microbial Diseases	4
Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of following diseases: Bacterial (Polio, Typhoid, Staphylococcal Food Poisoning) , Viral (Dengue, AIDS)	
Reference Books	
► Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley and Sons, New York. ► Atlas, R. M. and Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4th ed. ► Benjamin/ Cummings. Black, J. G. (2011). Microbiology: Principles and Explorations. 8th ed. John Wiley and Sons, New York. ► Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell. ► Pinehuk, G. (2003). Schaum's outline Series: Theory and Problems of Immunology. McGrawHill. ► Presscott, L. M., Harley, J. P. and Klein, D. A. (2011). Microbiology, 8th ed. McGrawHill, New York. ► Schlegel, H. G. (1993). General Microbiology. 7th ed. Cambridge University Press. ► Slonczeweski, J.L. and Foster, J.W. (2009). Microbiology- An Evolving Science. Norton. ► Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L. (1986). General Microbiology. 5th ed. Macmillan. ► Talaro, K. and Talaro, A. (1999). Foundations in Microbiology. 3rd ed. Dubuque, McGraw Hill. ► Tortora, G. J., Funke, B. R., and Case. C. L. (2008). Microbiology. An Introduction. 9th ed. Benjamin/Cummings Publishing. Menlo Park Calif. Voyleys, B. A. (2002). The biology of viruses, 2nd ed. McGraw-Hill.	

70. DSE Paper 3 (Group A)- Microbiology (Lab)

Microbiology	
	Credits
List of Practical	
1. Simple staining and Gram's staining of bacteria. 2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria. 3. Preparation of slant and stab. 4. Pure culture techniques: Spread plate, Pour plate and Streak plate 5. Biochemical test for characterization: Catalase, Nitrate-reduction, Indole production, Methyl Red and Voges-Proskauer Test. 6. Microbiological examination of milk (Methylene blue reductase test). 7. Sugar fermentation test.	

71. DSE Paper 3 (Group B)- Parasitology

Parasitology		
	4 Credits	**Class**
Unit 1: Introduction to Parasitology		2
Brief introduction of Parasitism, Parasite, Parasitoid carriers and Vectors (mechanical and biological vector) Host parasite relationship		
Unit 2: Parasitic Protists		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*		
Unit 3: Parasitic Platyhelminthes		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia sajinata*		
Unit 4: Parasitic Nematodes		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*, *Brugia malayi*		
Unit 5: Parasitic Arthropods		10
Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick *Ixodes*), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) and Bug (*Cimex*)		
Unit 5: Parasite Vertebrates		**2**
Brief account of Cookicutter Shark, Hood Mocking bird, Vampire bat		
Reference Books		
► Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors ► E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger		

- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
- Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
- K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

72. DSE Paper 3 (Group B)- Parasitology Lab

Parasitology	
	2 Credits
List of Practicals	

1. Identification of any stage of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* through permanent slides/micro photographs
2. Identification of adult and any stage of *Schistosoma haematobium*, *Taenia sajinata* through permanent slides/micro photographs
3. Identification of adult and any stage of *Ancylostoma duodenale*, *Brugia malayi* and *Trichinella spiralis* through permanent slides/micro photographs
4. Identification of *Pediculus humanus*, *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
6. Study of monogenea from the gills of fresh water fish [Gills can be procured from fish market as by-product of the industry/ Study of gut parasite of cockroach
7. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by-product]

(OUT OF TWO GROUPS OF DSE PAPER 3 STUDENTS HAVE TO SELECT ANY ONE GROUP)

73. DSE Paper 4 (Group A)-Animal Biotechnology (THEORY)

Animal Biotechnology		
	4 Credits	**Class**
Unit 1: Introduction		5
Organization of prokaryotic and eukaryotic genome, Concept of genomics		
Unit 2: Molecular Techniques in Gene manipulation		23
Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).Restriction enzymes: Nomenclature, detailed study of Type II. Transformation techniques: Calcium chloride method and electroporation. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization Southern, Northern and Western blotting DNA sequencing: Sanger method Polymerase Chain Reaction, DNA Finger Printing and DNA micro array		
Unit 3: Genetically Modified Organisms		12
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.		
Unit 4: Culture Techniques and Applications		10
Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)		
Reference Books		
► Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA. ► Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA. ► Weaver. Molecular Biology of Gene. 5th edition. ► Primrose & Twyman. Principles of Gene Manipulation and Genomics. 7th edition.		

74. DSE Paper 4 (Group A)- –Animal Biotechnology (Lab)

Animal Biotechnology	
	2 Credits
List of Practical	

1. Genomic DNA isolation from E. coli (method)
2. Plasmid DNA isolation (pUC 18/19) from E. coli (Boiling miniprep method)
3. Restriction digestion of plasmid DNA/ lambda DNA by *Eco*RI/ *Hin*dIII, electrophoresis and observation
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
    a. Southern Blotting
    b. Northern Blotting
    c. Western Blotting
    d. DNA Sequencing (Sanger's Method)
    e. PCR
    f. DNA fingerprinting
7. Project report on animal cell culture

75. DSE Paper 4 (Group B)- - Fish and Fisheries (THEORY)

Fish and Fisheries		
	4 Credits	**Class**
Unit 1: Introduction and Classification		**4**
General description of fish Feeding habit, habitat and manner of reproduction Classification of fish (up to Subclasses)		
Unit 2: Morphology and Physiology		14
Types of fins and their modifications; Locomotion in fish; 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; Reproductive strategies (special reference to Indian fish); Electric organ, Bioluminescence		
Unit 3: Fisheries		10
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		16
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		6
Transgenic fish Zebrafish as a model organism in research		
Reference Books		
► Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.		

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

Note: Classification to be followed from: Romar A. S. (1959)

76. DSE Paper 4 (Group B)-–Fish and Fisheries (Lab)

Fish and Fisheries	
	2 Credits

List of Practical

1. Morphometric and meristic characters of fishes
2. Identification of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
6. Study of air breathing organs in *Channa*/ *Heteropneustes*/ *Anabas*/ *Clarias*(Market variety)
7. Project Report on a visit to any fish farm/ pisciculture unit/ Zebrafish rearing Lab.

77. DSE Paper 4 (Group C)- Biology of Insects (THEORY)

Biology of Insects		
	4 Credits	**Class**
Unit 1: Introduction		2
General Features of Insects Distribution and Success of Insects on the Earth		
Unit 2: Insect Taxonomy		4
Basis of insect classification; Classification of insects up to orders (according to Brusca and Brusca, 2016)		
Unit 3: General Morphology of Insects		6
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia		
Unit 4: Physiology of Insects		20
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system Photoreceptors: Types, Structure and Function Metamorphosis: Types and Neuroendocrine control of metamorphosis		
Unit 5: Insect Society		6
Social insects with special reference to termites Trophallaxis in social insects such as ants, termites and bees		
Unit 6: Insect Plant Interaction		4
Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects, Major insect pests in paddy		

Unit 7: Insects as Vectors	**8**
Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors	
Reference Books	
► A general text book of entomology, Imms , A. D., Chapman & Hall, UK ► The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK ► Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA ► Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA ► The Insect Societies, Wilson, E. O., Harward Univ. Press, UK ► Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA ► Physiological system in Insects, Klowden, M. J., Academic Press, USA ► The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK ► Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA ► Mosquito, Chandra G (2000), Sribhumi Pub. Co. ► Medical Entomology, Hati A. K., Allied Book Agency, 2010	

Note: Classification to be followed from IMMS A. D. (1938)

78. DSE Paper 4 (Group C)-–Biology of Insects (Lab)

Biology of Insecta	
	2 Credits
List of Practical	
1. Study of life cycle of Mosquito/ Silk moth 2. Study of different kinds of antennae, legs and mouth parts of insects 3. Mounting of insect wings, spiracles and genitalia of any insects 4. Methodology of collection, preservation and identification of insects. 5. Morphological studies of various castes of *Apis, Camponotus Odontotermes* 6. Study of major insect pests of paddy/tea and their damages	

(OUT OF THREE GROUPS OF DSE PAPER 4 STUDENTS HAVE TO SELECT ANY ONE GROUP)

ZOOLOGY PROGRAMME

CBCS SYLLABUS (2018)

SCHEME AND SYLLABUS UNDER

CHOICE BASED CREDIT SYSTEM

B.Sc. Programme Course WITH

ZOOLOGY

	CORE COURSE (12)	**Ability Enhancement Compulsory Courses AEC (2)**	**Skill Enhancement Courses SEC (4)**	**Discipline Specific Elective DSE (4)**
I	DSC- Botany I DSC- Zoology I DSC- Chemistry I	AECC1		
II	DSC- Botany II DSC-Zoology II DSC- Chemistry II	AECC2		
III	DSC- Botany III DSC-Zoology III DSC- Chemistry III		SEC-I Paper-1	
IV	DSC- Botany IV DSC-Zoology IV DSC- Chemistry IV		SEC-I Paper-2	
V			SEC-II Paper-1	DSE-Botany I DSE-Zoology I DSE-Chemistry I
VI			SEC-II Paper-2	DSE-Botany II DSE-Zoology II DSE-Chemistry II

Discipline Core Courses: Zoology

1. Animal Diversity (SEM I)
2. Comparative Anatomy and Developmental Biology of Vertebrates (SEM II)
3. Physiology and Biochemistry (SEM III)
4. Genetics and Evolutionary Biology (SEM IV)

Skill Enhancement Courses: Zoology

1. Apiculture (SEM III, V)
2. Aquarium Fish Keeping (SEM III, V)
3. Sericulture (SEM IV, VI)
4. Medical Diagnostics (SEM IV, VI)

Discipline Specific Electives: Zoology (Any two)

1. Animal Biotechnology (SEM V)
2. Applied Zoology (SEM V)
3. Aquatic Biology (SEM V)
4. Immunology (SEM VI)
5. Reproductive Biology (SEM VI)
6. Insect,Vector and Diseases (SEM VI)

SEMESTER-I

DSC-Paper I ANIMAL DIVERSITY

THEORY **(CREDITS 4)**

Unit 1: Kingdom Protista **4**
General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

Unit 2: Phylum Porifera **3**
General characters and classification up to classes; Canal System in *Sycon*

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

Unit 4: Phylum Platyhelminthes **3**
General characters and classification up to classes; Life history of *Taenia solium*

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

Unit 6: Phylum Annelida **3**
General characters and classification up to classes; Metamerism in Annelida

Unit 7: Phylum Arthropoda **5**
General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

Unit 8: Phylum Mollusca **4**
General characters and classification up to classes; Torsion in gastropods

Unit 9: Phylum Echinodermata **4**
General characters and classification up to classes; Water-vascular system in *Asterias*

Unit 10: Protochordates **2**
General features and Phylogeny of Protochordata

Unit 11: Agnatha **2**
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces **4**
General features and Classification up to orders; Osmoregulation in Fishes

Unit 13: Amphibia **4**

General features and Classification up to orders; Parental care

Unit 14: Reptiles **4**

General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

Unit 15: Aves **5**

General features and Classification up to orders; Flight adaptations in birds

Unit 17: Mammals **5**

Classification up to orders; Origin of mammals

Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

ANIMAL DIVERSITY

PRACTICAL **(CREDITS 2)**

1. Study of the following specimens:
Amoeba, *Euglena*, *Plasmodium*, *Paramecium*, *Sycon*, *Hyalonema*, and *Euplectella*, *Obelia*, *Physalia*, *Aurelia*, *Tubipora*, *Metridium*, *Taenia solium*, Male and female *Ascaris lumbricoides*, *Aphrodite*, *Nereis*, *Pheretima*, *Hirudinaria*, *Palaemon*, *Cancer*, *Limulus*, *Palamnaeus*, *Scolopendra*, *Julus*, *Periplaneta*, *Apis*, *Chiton*, *Dentalium*, *Pila*, *Unio*, *Loligo*, *Sepia*, *Octopus*, *Pentaceros*, *Ophiura*, *Echinus*, *Cucumaria* and *Antedon*, *Balanoglossus*, *Herdmania*, *Branchiostoma*, *Petromyzon*, *Sphyrna*, *Pristis*, *Torpedo*, *Labeo*, *Exocoetus*, *Anguilla*, *Ichthyophis/Ureotyphlus*, *Salamandra*, *Bufo*, *Hyla*, *Chelone*, *Hemidactylus*, *Chamaeleon*, *Draco*, *Vipera*, *Naja*, *Crocodylus*, *Gavialis*, Any six common birds from different orders, *Sorex*, Bat, *Funambulus*, *Loris*

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

3. Key for Identification of poisonous and non-poisonous snakes

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

SUGGESTED READINGS

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

SEMESTER-II

DSC Paper 2- COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

THEORY **(CREDITS 4)**

Unit 1: Integumentary System **4**
Derivatives of integument Nails and hooves in birds and mammals

Unit 2: Skeletal System **3**
Evolution of visceral arches

Unit 3: Digestive System **4**
Brief aDSCount of alimentary canal and digestive glands

Unit 4: Respiratory System **5**
Brief aDSCount of Gills, lungs, air sacs and swim bladder

Unit 5: Circulatory System **4**
Evolution of heart and aortic arches

Unit 6: Urinogenital System **4**
SuDSCession of kidney, Evolution of urinogenital ducts

Unit 7: Nervous System **3**
Comparative aDSCount of brain

Unit 8: Sense Organs **3**
Types of receptors

Unit 9: Early Embryonic Development **12**
Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (Sea urchin), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula);types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

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

Unit 11: Control of Development **8**
Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

PRACTICAL **(CREDITS 2)**

1. Osteology:
   a) Disarticulated skeleton of Pigeon and Guineapig
   b) Mammalian skulls: One herbivorous (Guineapig) and one carnivorous animal (Dog)

2. Frog - Study of developmental stages - whole mounts and sections through permanent slides/ photograph – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.

3. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

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

SEMESTER-III

DSC Paper 3- PHYSIOLOGY AND BIOCHEMISTRY

THEORY **(CREDITS 4)**

Unit 1: Nerve and muscle **8**

Structure of a neuron, Resting membrane potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2: Digestion **5**

Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 3: Respiration **5**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion **5**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system **6**

Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands **7**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle

Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism **8**

Glycolysis, Krebs cycle, Pentose phosphate pathway, Review of electron transport chain

Unit 8: Lipid Metabolism 5

β oxidation of palmitic acid

Unit 9: Protein metabolism **5**

Transamination, Deamination and Urea Cycle

Unit 10: Enzymes

Mechanism of action, Enzyme Kinetics, Inhibition **6**

PHYSIOLOGY AND BIOCHEMISTRY

PRACTICAL **(CREDITS 2)**

1. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
2. Identification of permanent slides of ileum, liver, lung, kidney
3. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
2. Estimation of total protein in given solutions by Lowry's method.
3. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

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

SEC 1 Paper-1 (Group A)-APICULTURE (Theory)

(CREDITS 2)

Unit 1: Biology of Bees **(4)**
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 **(5)**
Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy **(2)**
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture **(4)**
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, NewDelhi.

SEC 1 Paper-1 (Group B)-AQUARIUM FISH KEEPING (Theory)

(CREDITS 2)

Unit1: Introduction to Aquarium Fish Keeping

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

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

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

Unit 4: Fish Transportation

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

Unit 5: Maintenance of Aquarium

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

(OUT OF TWO GROUPS OF SEC1 PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-IV

DSC- Paper 4 GENETICS AND EVOLUTIONARY BIOLOGY

THEORY **(CREDITS 4)**

Unit 1: Introduction to Genetics **3**

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension **8**

Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping **9**

Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence

Unit 4: Mutations **7**

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

Unit 5: Sex Determination **4**

Chromosomal mechanisms, Mechanism of sex determination in *Drosophila*, dosage compensation

Unit 6: Origin of Life **2**

Major Events in Origin of Life

Unit 7: Introduction to Evolutionary Theories **5**

Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution **5**

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change **9**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 10: Species Concept **6**

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro-evolution **5**

Macro-evolutionary Principles (example: Darwin's Finches)

Unit 12: Extinction **6**

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY

PRACTICAL **(CREDITS 2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal) (from photograph).
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/ Nature interpretation centre and submission of report

SUGGESTED READINGS

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

SEC 1 Paper-2 (Group A)-SERICULTURE (Theory)

(CREDITS 2)

Unit 1: Introduction **(3)**

Sericulture: Definition,

Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm **(3)**
Life cycle of *Bombyx mori*
Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms **(13)**
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, RKO
Silkworm rearing technology: Early age and Late age rearing Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases **(4)**
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture **(2)**
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.

SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.

Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986

SEC 1 Paper-2 (Group B)-MEDICAL DIAGNOSTICS (Theory)

(CREDITS 2)

Unit 1: Introduction to Medical Diagnostics and its Importance **2**

Unit 2: Diagnostics Methods Used for Analysis of Blood **10**

Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3: Diagnostic Methods Used for Urine Analysis **6**

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4:Non-infectious Diseases **6**

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit (Principle)

Unit 5: Infectious Diseases **3**

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours **3**

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

(OUT OF TWO GROUPS OF SEC1 PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-V

DSE Paper-1 (Group A)- ANIMAL BIOTECHNOLOGY

THEORY **(Credits 4)**

Unit 1: Introduction **8**

Concept and scope of biotechnology

Unit 2: Molecular Techniques in Gene manipulation **24**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)

Restriction enzymes: Nomenclature, detailed study of Type II.

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

General concept of Southern, Northern and Western blotting; DNA sequencing:

Sanger method, Polymerase Chain Reaction, DNA Finger Printing and DNA micro

array

Unit 3: Genetically Modified Organisms **18**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.

Unit 4: Culture Techniques and Applications **10**

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

PRACTICAL **(Credits 2)**

1. Genomic DNA isolation from *E. coli* (method -)
2. Plasmid DNA isolation (pUC 18/19) from *E. coli* (Boiling MiniPrep method) – Holmes & Quigly method
3. Restriction digestion of plasmid DNA/ Lambda DNA using *Eco*RI/ *Hin*dIII, eloctrophoresis and observation
4. To study following techniques through photographs
   a) Southern Blotting
   b) Northern Blotting
   c) Western Blotting
   d) DNA Sequencing (Sanger's Method)
   e) PCR
   f) DNA fingerprinting
5. Project report on animal cell culture

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis.* II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics.* V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y., USA.
- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics.* VI Edition, Oxford University Press.

DSE Paper-1 (Group B**) APPLIED ZOOLOGY**

THEORY **(CREDITS 4)**

Unit 1: Introduction to Host-parasite Relationship **3**
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases **7**
Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsiae **6**
Brief aDSCount of *Rickettsia prowazekii*

Unit 4: Parasitic Protozoa **8**
Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax*

Unit 5: Parasitic Helminthes **5**
Life history and pathogenicity of *Ancylostoma duodenale* and *Taenia solium*

Unit 6: Insects of Economic Importance **8**
Biology, Control and damage caused by *Helicoverpa armigera, Papilio demoleus,Heloveltis theivora, Sitophilus oryzae* and *Tribolium castaneum*

Unit 7: Insects of Medical Importance **8**
Medical importance and control of *Anopheles, Aedes, Xenopsylla cheopis*

Unit 8: Animal Husbandry **5**
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

Unit 9: Poultry Farming **5**
Principles of poultry breeding, Management of breeding stock and broilers

Unit 10: Fish Technology **5**
Concept of monoculture, polyculture, monosex culture, pen culture, cage culture, Induced breeding and transportation of fish seed

PRACTICAL **(CREDITS 2)**

1. Identification of *Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* and any of their life stages through permanent slides/photomicrographs or specimens.
2. Identification of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes* and *Xenopsylla.*
3. Study of insect damage to different plant parts/stored grains through damaged products/ photographs and submission of any three crop pest.
4. Identifying feature and economic importance of *Helicoverpa* (*Heliothis*) *armigera, Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Submission of report on poultry farm/ animal breeding centre

SUGGESTED READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia,* Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR).
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

DSE Paper-1 (Group C**) AQUATIC BIOLOGY**

THEORY **(Credits 4)**

UNIT 1: Aquatic Biomes

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

Lakes: Lake as an Ecosystem, 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: Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology

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

UNIT 4: Management of Aquatic Resources

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills,

Eutrophication, Management and conservation (legislations), Sewage treatment

Water quality assessment- BOD and COD.

PRACTICAL **(Credits 2)**

1. Determine the area of a pond using graphimetric and gravimetric method.
2. Identify the important zooplanktons present in a lake ecosystem.
3. Determine the amount of Dissolved Oxygen, Free Carbon dioxide, Total Alkalinity in water collected from a nearby lake/ water body.
4. Instruments used in limnology (SeDSChi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

SUGGESTED READINGS

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

(OUT OF THREE GROUPS OF DSE PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEC 2 Paper-1 (Group A)-APICULTURE (Theory)

(CREDITS 2)

Unit 1: Biology of Bees **(4)**
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 **(5)**
Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy **(2)**
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture **(4)**
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, NewDelhi.

SEC 2 Paper-1 (Group B)-AQUARIUM FISH KEEPING (Theory)

(CREDITS 2)

Unit1: Introduction to Aquarium Fish Keeping

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

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

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

Unit 4: Fish Transportation

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

Unit 5: Maintenance of Aquarium

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

(OUT OF TWO GROUPS OF SEC2 PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-VI

DSE Paper-2 (Group A)- IMMUNOLOGY

THEORY **(CREDITS 4)**

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

Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2: **Cells and Organs of the Immune System** **8**

Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens **8**

Basic properties of antigens, B and T cell epitopes, haptens and adjuvants

Unit 4: **Antibodies** **8**

Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 5: **Working of the immune system** **12**

Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways (classical and alternate).

Unit 6: **Immune system in health and disease** **10**

Gell and Coombs' classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency,

Unit 7: VaDSCines **4**

General introduction to vaDSCines, Various types of vaDSCines: Brief idea

PRACTICAL **(CREDITS 2)**

1. Demonstration of lymphoid organs
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of leucocytes.
4. Ouchterlony's double immuno-diffusion method (demonstration).
5. ABO blood group determination.
6. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of
   a) ELISA
   b) Immunoelectrophoresis

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.

- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.

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

- Immunology and Immunotechnology (2005) Chakravarty A..K. (Oxford University Press).

DSE Paper-2 (Group B)- REPRODUCTIVE BIOLOGY

THEORY (CREDITS 4)

Unit 1: Reproductive Endocrinology

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts.

Unit 2: Functional anatomy of male reproduction

Anatomy of male reproductive system in rat and human; Histoarchitecture of Testis, Spermatogenesis, Androgen synthesis and metabolism; Epididymal function and sperm maturation; ADSCessory glands functions.

Unit 3: Functional anatomy of female reproduction

Anatomy of female reproductive system in rat and human; Histoarchitecture of Ovary, folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 4: Reproductive Health

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, IUT, ICSI; Modern contraceptive technologies.

PRACTICAL (CREDITS 2)

1. Report on an established animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear from live rats.
3. Demonstration of reproductive organs.
4. Identification of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and aDSCessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Sperm count and sperm motility in rat (demonstration).

SUGGESTED READINGS

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

DSE Paper-**2** (Group C)- **INSECT, VECTORS AND DISEASES**

THEORY **(Credits 4)**

Unit I: Introduction to Insects **6**

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

Unit II: Concept of Vectors **6**

Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity

Unit III: Insects as Vectors **8**

Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit IV: Dipteran as Disease Vectors **24**

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;

Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes

Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly

Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit IV: Siphonaptera as Disease Vectors **6**

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit V: Siphunculata as Disease Vectors **4**

Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

Unit VI: Hempitera as Disease Vectors **6**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

PRACTICAL **(CREDITS 2)**

1. Identification of different kinds of mouth parts of insects (from slides/ photographs)
2. Identification of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica.,*
3. Study of different diseases transmitted by above insect vectors
4. Submission of a project report on any one of the insect vectors and disease transmitted

SUGGESTED READINGS

- Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK
- Chapman, R.F. (1998). *The Insects: Structure and Function.* IV Edition, Cambridge University Press, UK
- Pedigo L.P. (2002). *Entomology and Pest Management.* Prentice Hall Publication
- Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases.* Wiley-Blackwell

(OUT OF THREE GROUPS OF DSE PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEC 2 Paper-2 (Group A)-SERICULTURE (Theory)

(CREDITS 2)

Unit 1: Introduction **(3)**

Sericulture: Definition,

Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm **(3)**
Life cycle of *Bombyx mori*
Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms **(13)**
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, RKO
Silkworm rearing technology: Early age and Late age rearing Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases **(4)**
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture **(2)**
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.

SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.

Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986

SEC 2 Paper-2 (Group B)-MEDICAL DIAGNOSTICS (Theory)

(CREDITS 2)

Unit 1: Introduction to Medical Diagnostics and its Importance **2**

Unit 2: Diagnostics Methods Used for Analysis of Blood **10**

Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3: Diagnostic Methods Used for Urine Analysis **6**

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4:Non-infectious Diseases **6**

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit (Principle)

Unit 5: Infectious Diseases **3**

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours **3**

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

(OUT OF TWO GROUPS OF SEC2 PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

ZOOLOGY HONOURS

CBCS SYLLABUS

(2020)

2.2. Scheme for CBCS Curriculum (Zoology Honours)

YEAR	SEMESTER	CORE COURSE (CC) (14T+14L) (Credit 14x4+ 14x2)	ABILITY ENHANSMENT COMPULSORY COURSE (AECC)(2T) (Credit 2x2)	SKILL ENHANSMENT COMPULSORY COURSE (SEC)(2T) (Credit 2x2)	DISCIPLINE SPECIFIC ELECTIVES (DSE) (4T+4L) (Credit 4x4+ 4x2)	GENERIC ELECTIVES (GE) (4T+4L) (Credit 4x4+ 4x2) (For other Disciplines)	TOTAL CREDITS
1	I	CC-1 NON-CHORDATE I CC-2 ECOLOGY	AECC-1 ENVIRONMENTAL SCIENCE			GE1 PAPER-1 * Gr.A-ANIMAL DIVERSITY Gr. B-INSECT VECTORS Gr.C-AQUATIC BIOLOGY	20
	II	CC-3 NON-CHORDATE II CC-4 CELL BIOLOGY	AECC-2 ENGLISH COMMUNICATION/ MAJOR INDIAN LANGUAGE			GE1 PAPER-2* Gr.A-HUMAN PHYSIOLOGY Gr.B-FOOD NUTRITION & HEALTH Gr.C-ENVIRONMENT AND PUBLIC HEALTH Gr.D-ANIMAL CELL BIOTECHNOLOGY	20
2	III	CC-5 CHORDATES CC-6 ANIMAL PHYSIOLOGY: CONTROLING & COORDINATING SYSTEM CC-7 GENETICS		SEC PAPER-1 * Gr.A-APICULTURE Gr.B-AQUADIUM FISH KEEPING		GE2 PAPER-1 * Gr.A-ANIMAL DIVERSITY Gr. B-INSECT VECTORS Gr.C-AQUATIC BIOLOGY	26
	IV	CC-8 COMPARATIVE ANATOMY OF VERTEBRATES CC-9 ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS CC-10 FUNDAMENTALS OF BIOCHEMISTRY		SEC PAPER- 2 * Gr.A-SERICULTURE Gr.B-MEDICAL DIAGNOSTIC TECHNIQUES		GE2 PAPER-2* Gr.A-HUMAN PHYSIOLOGY Gr.B-FOOD NUTRITION & HEALTH Gr.C-ENVIRONMENT AND PUBLIC HEALTH Gr.D-ANIMAL CELL BIOTECHNOLOGY	26
3	V	CC-11 MOLECULAR BIOLOGY CC-12 IMMUNOLOGY			DSE PAPER-1* Gr.A- REPRODUCTIVE BIOLOGY, Gr. B-ENDOCRINOLOGY DSE PAPER-2 * Gr.A- ANIMAL BEHAVIOUR & CHRONOBIOLOGY Gr.B- WILDLIFE CONSERVATION & MANAGEMENT		24
	VI	CC-13 DEVELOPMENTAL BIOLOGY CC-14 EVOLUTIONARY BIOLOGY AND BIOSTATISTICS			DSE PAPER-3 * Gr.A- MICROBIOLOGY Gr.B-PARASITOLOGY DSE PAPER-4 * Gr.A- ANIMAL BIOTECHNOLOGY Gr.B- FISH & FISHERIES Gr.C- BIOLOGY OF INSECTS		24
TOTAL		**56+28=84**	**4**	**4**	**16+8=24**	**16+8=24**	**140**

*Students have to select any one group for the respective course

SEMESTER-I

1. CC1- Non-Chordates I (THEORY)

Non-Chordates I		
	4 Credits	**Class**
Unit 1: Basics of Animal Classification		4
Definitions: Classification, Systematics and Taxonomy; Levels of Taxonomy: Alpha, Beta & Gamma Taxonomy; Taxonomic Hierarchy, Taxonomic types: Primary, Secondary (Definition) Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy. Kingdom concept of classification (Whittaker)		
Unit 2: Protista		15
Protozoa General characteristics and Classification up to phylum (according to Levine et. al., 1981), Locomotion in *Amoeba*; Conjugation in *Paramoecium*. Life cycle and pathogenicity of *Plasmodium vivax*		
Unit 3: Porifera		6
General characteristics and Classification up to classes; Cell types, Spicules in sponges, Canal system in *Sycon*		
Unit 4: Cnidaria		10
General characteristics and Classification up to classes Metagenesis (Definition) Corals and coral reefs diversity, function & conservation		
Unit 5: Ctenophora		2
General characteristic		

Unit 6: Platyhelminthes	6
General characteristics and Classification up to classes Life cycle of *Taenia solium*	
Unit 7: Nematoda	7
General characteristics and Classification up to classes Life cycle of *Wuchereria bancrofti*	
Reference Books	
► Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition. ► Invertebrates by Brusca & Brusca. Second edition, 2002.	
Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th Edition.	

2. CC1 –Non-Chordates I (Lab)

Non-Chordates I	
	2 credits
List of Practical	
1. Preparation of whole mount of *Paramoecium* (only protocol) 2. Identification with reasons: *Amoeba*, *Euglena*, *Opalina*, *Paramecium*, (from the photographs) 3. Identification with reasons: (from the photographs) *Sycon*, *Obelia*, *Physalia*, *Aurelia*, *Tubipora*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, 4. Spot identification (from the photographs) of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides* 5. Staining/mounting of any protozoa from gut of cockroach (only protocol)	

3. CC2 –Ecology (THEORY)

Ecology		
	4 Credits	**Class**
Unit 1: Introduction to Ecology		4
Autecology and synecology, Laws of limiting factors, Study of Physical factors (light and temperature), The Biosphere - Introduction.		
Unit 2: Population		20
Unique and group attributes of population: Demographic factors, life tables, survivorship curves Exponential and logistic growth, equation and patterns, r and k strategies, Population Interactions, Gause's Principle with laboratoryexamples, Lotka-Volterra equation for competition.		
Unit 3: Community		11
Community characteristics: species diversity, abundance, dominance, richness, Ecotone and edge effect. Ecological succession in a pond ecosystem.		
Unit 4: Ecosystem		10
Types of ecosystem, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids General concept of biogeochemical cycle with an example of Nitrogen cycle		
Unit 5: Applied Ecology		5
Wildlife Conservation (in-situ and ex-situ conservation).		
Reference Books		
► Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings. ► Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole ► Robert Leo Smith Ecology and field biology Harper and Row publisher ► Ecology: Theories & Application (2001). 4th Edition by Peter Stilling. ► Ecology by Cain, Bowman & Hacker. 3rd edition. Sinauer associates		

4. CC2–Ecology (Lab)

Ecology	
	2 Credits
List of Practical	
1. Study of life tables and plotting of survivorship curves of different types from the hypothetical provided 2. Determination of population density in a hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community 3. Study of an aquatic ecosystem: Dissolved Oxygen content (Winkler's method) (protocol only), free CO_2 (protocol only) 4. Submission of a report on wild life diversity of any National Park/ Wild life sanctuary	

5. GE 1 (Group-A) -Animal Diversity (THEORY)

Animal Diversity		
	4 Credits	**Class**
Unit 1: Protista		**3**
Protozoa General characters of Protozoa		
Unit 2: Porifera		3
General characters of Porifera		
Unit 3: Radiata		3
General characters of Cnidarians		
Unit 4: Aceolomates		2
General characters of Platyhelminthes		
Unit 5: Pseudocoelomates		3
General characters of Nematoda		
Unit 6: Annelida		3
General characters of Annelida		
Unit 7: Arthropoda		4
General characters		
Unit 8: Mollusca		4
General characters of mollusc		
Unit 9: Echinodermata		4
General characters of Echinodermata Water Vascular system in Starfish		

Unit 10: Protochordata	2
Salient features of Urochordata and Cephalochordata	
Unit 11: Pisces	3
General Characters, Migration of Fish	
Unit 12: Amphibia	4
General characters	
Unit 13: Reptilia	4
General Characters, Differences between poisonous and non-poisonous snakes, poison apparatus, venom	
Unit 14: Aves	4
General Characters	
Unit 15: Mammalia	4
General Characters	
Reference Books	
► Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA. ► Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole ► Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.	
► Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi. ► Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.	

6. GE 1 (Group-A) –Animal Diversity (Lab)

Animal Diversity	
	2 Credits
List of Practical	
1. Spot identification (photographs): a. Non Chordates: *Paramecium*, *Sycon*, *Metridium*, *Taenia*, *Ascaris*, *Nereis Limulus*, *Chiton*, *Octopus*, *Asterias*, b. Chordates: *Amphioxus*, Scoliodon, *Hippocampus*, *Labeo*, *Icthyophis*, Salamander, *Draco*, *Naja*, Owl and Bat. 2. Identification of following specimen through photographs: Cross section of *Sycon*, T. S. of Earthworm passing through typhlosolar intestine. Bipinnarialarva.	

7. GE 1 (Group-B) -Insect Vectors and Diseases (THEORY)

Insect Vectors and Diseases		
	4 Credits	**Class**
Unit 1: Introduction to Insects		2
General Features of Insects, Types of antennae, Mouth parts (with reference to feeding)		
Unit 2: Concept of Vectors		4
Brief introduction to Carriers and Vectors (mechanical and biological vectors), Reservoirs,		
Unit 3: Insects as Vectors		6
Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera		
Unit 4: Dipteran as Disease Vectors		20
Dipterans as important insect vectors – Mosquitoes Study of mosquito-borne diseases – Malaria, Dengue, Control of mosquitoes		
Unit 5: Siphonaptera as Disease Vectors		6
Fleas as important insect vectors, Study of Flea-borne diseases – Plague, Control of fleas		
Unit 6: Siphunculata as Disease Vectors		6
Human louse (Head louse) as important insect vectors; Control of human louse		
Unit 7: Hempitera as Disease Vectors		6
Bugs as insect vectors; Blood-sucking bugs; Bed bugs as mechanical vectors, Control measures		
Reference Books		
► Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK ► Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK ► Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication ► Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell ► Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata ► Medical Entomology, Hati A. K Allied Book Agency, Kolkata		

8. GE 1 (Group-B) –Insect Vectors and Diseases (Lab)

Insect Vectors and Diseases	
	2 Credits
List of Practical	
1. Identification of different kinds of mouth parts of insects (photographs) 2. Identification of following insect vectors through photographs: *Aedes*, *Culex*, *Anopheles*, *Phithirus pubis*, *Phlebotomus argentipes*, *Musca domestica* 3. Study of different diseases transmitted by above insect vectors 4. Submission of a project report on any one of the insect vectors and disease transmitted	

9 . GE 1 (Group-C)-Aquatic Biology (THEORY)

Aquatic Biology		
	4 Credits	**Class**
Unit 1: Aquatic Biomes		**10**
Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone		
Unit 2: Freshwater Biology		20
Lakes: Lake as an Ecosystem, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen).		
Unit 3: Marine Biology		10
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs		
Unit 4: Management of Aquatic Resources		10
Causes of pollution: Agricultural, Industrial, Sewage, and Oil spills, Eutrophication, Sewage treatment Water quality assessment- BOD and COD.		
Reference Books		
► Anathakrishnan : Bioresources Ecology 3rd Edition ► Goldman : Limnology, 2nd Edition ► Odum and Barrett : Fundamentals of Ecology, 5th Edition ► Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition ► Wetzel : Limnology, 3rd edition ► Trivedi and Goyal : Chemical and biological methods for water pollution studies ► Welch : Limnology Vols. I-II		

10. GE 1 (Group-C)–Aquatic Biology (Lab)

Aquatic Biology	
	2 Credits
List of Practical	
1. Identification of the important zooplanktons present in a pond ecosystem. (from photograph) 2. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance (from photograph).	

(OUT OF THREE GROUPS OF GE 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-III

23. CC 5 – Chordates (THEORY)

Chordates		
	4 Credits	**Class**
Unit 1: Introduction to Chordates		2
General characteristics and outline classification of Phylum Chordata (upto class level)		
Unit 2: Protochordata		6
General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in *Ascidia*.		
Unit 3: Agnatha		2
General characteristics Zoological importance of ammocoete larva		
Unit 4: Pisces		6
General characteristics of Chondrichthyes and Osteichthyes Migration in fishes		
Unit 5: Amphibia		6
General characteristics and classification up to living Orders. Metamorphosis in toad, Neoteny		
Unit 6: Reptilia		8
General characteristics and classification up to living Orders. Poison apparatus in poisonous Snakes		
Unit 7: Aves		8
General characteristics Double respiration in Birds , Principles and aerodynamics of flight		
Unit 8: Mammals		8
General characters General characters of Prototheria, Echolocation in Micro chiropterans		
Unit 9: Zoogeography		2
Zoogeographical realms, distribution of birds (flightless) and mammals in different realms		

Reference Books

- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Parker, T. J. &Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
- Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
- Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
- Nelson, J.S., (2006) : Fishes of the World, 4th Edn., Wiley.
- Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
- Jordan, E.L. &Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
- Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Duellman and Trueb (1986)/ Young (1981).

24. CC 5–Chordates (Lab)

Chordates	
	2 Credits

List of Practical

Identification with reasons:

1. Protochordata

   Branchiostoma

2. Agnatha

   Petromyzon, Myxine

3. Fishes

   Scoliodon Torpedo, Heteropneustes, Labeo, Hippocampus, Tetrodon, Anabas

4. Amphibia

   Necturus, Axolotl,- Tylototriton, Hyla

5. Reptilia

   Chelone, Varanus, Chamaeleon, Draco, Bungarus, Vipera, Naja, Key for Identification of poisonous and non-poisonous snakes

6. Mammalia: Bat (Insectivorous and Frugivorous),

25. CC 6 - Animal Physiology: Controlling & Coordinating Systems (THEORY)

Animal Physiology: Controlling & Coordinating Systems		
	4 Credits	**Class**
Unit 1: Tissues		4
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue		
Unit 2: Nervous System		10
Structure and types of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission		
Unit 3: Muscular system		10
Ultra structure of skeletal muscle; Molecular and chemical basis of skeletal muscle contraction;		
Unit 5: Reproductive System		6
Roles of Hormones in Reproduction		
Unit 6: Endocrine System		16
Function of pituitary, thyroid, pancreas and adrenal gland Classification of hormones; Mechanism of Hormone action		
Signal transduction pathways for Steroidal, Protein and peptide hormones		
Reference Books		
► Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins. ► Eckert Animal Physiology by David Randall and Warren Burggren. 4th edition. W. H. Freeman.		

26. CC 6–Animal Physiology: Controlling & Coordinating Systems (Lab)

Animal Physiology: Controlling & Coordinating Systems	
	2 Credits
List of Practical	
1. Identification of permanent slides of Mammalian Pituitary, Pancreas, Testis, Ovary, Adrenal, and Thyroid (through photographs) 2. Microtomy: Preparation of permanent slide (protocol only) of mammalian tissues	

27. CC 7 – Genetics (THEORY)

Genetic		
	4 Credits	**Class**
Unit 1: Mendelian Genetics and its Extension		10
Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Sex-linked inheritance,		
Unit 2: Linkage, Crossing Over		10
Linkage and Crossing Over, molecular mechanism of crossing over (Holliday model)		
Unit 3: Mutations		**10**
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number;		
Unit 4: Sex Determination		8
Mechanisms of sex determination in *Drosophila* Sex determination in mammals, Dosage compensation in Human		
Unit 5: Extra-chromosomal Inheritance		4
Criteria for extra chromosomal inheritance Kappa particle in *Paramoecium*		
Unit 6: Recombination in Bacteria		6
Conjugation		
Reference Books		
► Developmental biology by Scott. F. Gilbert, 9th edition. ► Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc ► Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings ► Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings ► Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.		

28. CC 7–Genetics (Lab)

Genetics	
	2 Credits
List of Practical	
1. Chi-square analyses 2. Pedigree analysis of some human inherited traits	

29. SEC 1 (Group-A) –Apiculture (THEORY)

Apiculture		
	2 Credits	**Class**
Unit 1: Biology of Bees		**2**
Classification and Life cycle of Honey Bees		
Unit 2: Rearing of Bees		10
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Selection of Bee Species for Apiculture		
Unit 3: Diseases and Enemies		5
Bee Diseases Control and Preventive measures		
Unit 4: Bee Economy		2
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc ***Submission of a report on apiary/modern bee industry (20 marks)**		
Reference Books		
► 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.		

30. SEC Paper 1 (Group-B)-Aquarium Fish Keeping (THEORY)

Aquarium Fish Keeping		
	2 Credits	**Class**
Unit 1: Introduction to Aquarium Fish Keeping		**2**
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 such as Guppy, Molly, Gold fish, Angel fish		
Unit 3: Food and feeding of Aquarium fishes		7
Use of live fish feed organisms. Preparation and composition of formulated fish feeds,		
Unit 4: Fish Transportation		3
Live fish transport - Fish handling, packing and forwarding techniques. • **Submission of a report on Aquarium maintenance (20 marks)**		

Reference Books:

- Anshuman D. Dholakia. 2016. Ornamental Fish Culture and Aquarium Management. Astral International.
- Harishanker J. Alappat;A. 2011. Biju Kumar. Aquarium Fishes: A Colourful Profile. BR Publishing Corporation
- Sarij K. Swain, N. Sarangi and S. Ayyappan. 2010. Ornamental Fish Farming. Indian Council of Agricultural Research.

(OUT OF TWO GROUPS OF SEC PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

31. GE 3 (Group-A) -Animal Diversity (THEORY)

Animal Diversity		
	4 Credits	**Class**
Unit 1: Protista		**3**
Protozoa General characters of Protozoa		
Unit 2: Porifera		3
General characters of Porifera		
Unit 3: Radiata		3
General characters of Cnidarians		
Unit 4: Aceolomates		2
General characters of Platyhelminthes		
Unit 5: Pseudocoelomates		3
General characters of Nematoda		
Unit 6: Annelida		3
General characters of Annelida		
Unit 7: Arthropoda		4
General characters		
Unit 8: Mollusca		4
General characters of mollusc		
Unit 9: Echinodermata		4
General characters of Echinodermata Water Vascular system in Starfish		

Unit 10: Protochordata	2
Salient features of Urochordata and Cephalochordata	
Unit 11: Pisces	3
General Characters, Migration of Fish	
Unit 12: Amphibia	4
General characters	
Unit 13: Reptilia	4
General Characters, Differences between poisonous and non-poisonous snakes, poison apparatus, venom	
Unit 14: Aves	4
General Characters	
Unit 15: Mammalia	4
General Characters	
Reference Books	
► Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA. ► Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole ► Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.	
► Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi. ► Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.	

32. GE 3 (Group-A) –Animal Diversity (Lab)

Animal Diversity	
	2 Credits
List of Practical	
1. Spot identification (photographs): a. Non Chordates: *Paramecium*, *Sycon*, *Metridium*, *Taenia*, *Ascaris*, *Nereis Limulus*, *Chiton*, *Octopus*, *Asterias*, b. Chordates: *Amphioxus*, Scoliodon, *Hippocampus*, *Labeo*, *Icthyophis*, Salamander, *Draco*, *Naja*, Owl and Bat. 2. Identification of following specimen through photographs: Cross section of *Sycon*, T. S. of Earthworm passing through typhlosolar intestine. Bipinnarialarva.	

33. GE 3 (Group-B) -Insect Vectors and Diseases (THEORY)

Insect Vectors and Diseases		
	4 Credits	**Class**
Unit 1: Introduction to Insects		2
General Features of Insects, Types of antennae, Mouth parts (with reference to feeding)		
Unit 2: Concept of Vectors		4
Brief introduction to Carriers and Vectors (mechanical and biological vectors), Reservoirs,		
Unit 3: Insects as Vectors		6
Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera		
Unit 4: Dipteran as Disease Vectors		20
Dipterans as important insect vectors – Mosquitoes Study of mosquito-borne diseases – Malaria, Dengue, Control of mosquitoes		
Unit 5: Siphonaptera as Disease Vectors		6
Fleas as important insect vectors, Study of Flea-borne diseases – Plague, Control of fleas		
Unit 6: Siphunculata as Disease Vectors		6
Human louse (Head louse) as important insect vectors; Control of human louse		
Unit 7: Hempitera as Disease Vectors		6
Bugs as insect vectors; Blood-sucking bugs; Bed bugs as mechanical vectors, Control measures		
Reference Books		
► Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK ► Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK ► Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication ► Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell ► Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata ► Medical Entomology, Hati A. K Allied Book Agency, Kolkata		

34. GE 3 (Group-B) –Insect Vectors and Diseases (Lab)

Insect Vectors and Diseases	
	2 Credits
List of Practical	
1. Identification of different kinds of mouth parts of insects (photographs) 2. Identification of following insect vectors through photographs: *Aedes*, *Culex*, *Anopheles*, *Phithirus pubis*, *Phlebotomus argentipes*, *Musca domestica* 3. Study of different diseases transmitted by above insect vectors 4. Submission of a project report on any one of the insect vectors and disease transmitted	

35 . GE 3 (Group-C)-Aquatic Biology (THEORY)

Aquatic Biology		
	4 Credits	**Class**
Unit 1: Aquatic Biomes		**10**
Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone		
Unit 2: Freshwater Biology		20
Lakes: Lake as an Ecosystem, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen).		
Unit 3: Marine Biology		10
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs		
Unit 4: Management of Aquatic Resources		10
Causes of pollution: Agricultural, Industrial, Sewage, and Oil spills, Eutrophication, Sewage treatment Water quality assessment- BOD and COD.		
Reference Books		
► Anathakrishnan : Bioresources Ecology 3rd Edition ► Goldman : Limnology, 2nd Edition ► Odum and Barrett : Fundamentals of Ecology, 5th Edition ► Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition ► Wetzel : Limnology, 3rd edition ► Trivedi and Goyal : Chemical and biological methods for water pollution studies ► Welch : Limnology Vols. I-II		

36. GE 3 (Group-C)–Aquatic Biology (Lab)

Aquatic Biology	
	2 Credits
List of Practical	
1. Identification of the important zooplanktons present in a pond ecosystem. (from photograph) 2. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance (from photograph).	

(OUT OF THREE GROUPS OF GE 3 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-V

53. CC 11 - Molecular Biology (THEORY)

Molecular Biology		
	4 Credits	**Class**
Unit 1: Nucleic Acids		5
Watson and Crick Model of DNA, Clover leaf model of tRNA		
Unit 2: DNA Replication		10
Mechanism of DNA Replication in Prokaryotes		
Unit 3: Transcription		**10**
Mechanism of Transcription in prokaryotes		
Unit 4: Translation		**12**
Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, aminoacyl tRNA synthetases and charging of tRNA; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis		
Unit 5: Gene Regulation		**4**
Regulation of Transcription in prokaryotes: *lac* operon		
Unit 6: DNA Repair Mechanisms		4
Types of DNA repair mechanisms, nucleotide and base excision repair		
Unit 7: Molecular Techniques		**5**
Basic Principles of PCR, Sanger DNA sequencing		
Reference Books		
► Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman. ► Molecular Biology of The Gene by Watson. 7th Edition. Pearson. ► iGenetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.		

54. CC 11–Molecular Biology (Lab)

Molecular Biology	
	2 Credits
List of Practical	
1. Demonstration of polytene and lampbrush chromosome from photograph 2. Quantification of DNA using colorimeter (diphenylamine method) (Protocol only) 3. Agarose gel electrophoresis for DNA (Protocol only)	

55. CC 12 – Immunology (THEORY)

Immunology		
	4 Credits	**Class**
Unit 1: Overview of Immune System		2
Cells and organs of the Immune system		
Unit 2: Innate and Adaptive Immunity		12
Innate immunity, Adaptive immunity (Cell mediated and humoral). Structure of B and T cell Receptor and T-cell signaling		
Unit 3: Antigens		4
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, B and T-Cell epitopes		
Unit 4: Immunoglobulins		8
Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA)		
Unit 5: Major Histocompatibility Complex		2
Structure and functions of Class I and Class II MHC molecules.		
Unit 6: Cytokines		2
Types, properties and functions of cytokines.		
Unit 7: Complement System		6
Components and pathways of complement activation (Classical).		
Unit 8: Hypersensitivity		4
Gell and Coombs' classification of hypersensitivities.		
Unit 9: Vaccines		4
Various types of vaccines. Active & passive immunization (Artificial and natural).		
Reference Books		

►Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.

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

►Ashim Kumar Chakraborty (2005). Immunology and Immunotechnology. Oxford University Press

►Delves, Peter J.; Martin, Seamus J.; Burton, Dennis R.; Roitt, Ivan M. (2011). Roitt's Essential Immunology. Hoboken, NJ: Wiley-Blackwell

►David Male Jonathan Brostoff David Roth Ivan Roitt (2012). Immunology 8th Edition, Elsevier

56. CC 12–Immunology (Lab)

Immunology	
	2 Credits
List of Practical	
1. Demonstration of lymphoid organs.(through photographs) 2. Identification of spleen, thymus and lymph nodes (through photographs) 3. Study of various types of leukocytes (through photographs) .	

57. DSE Paper 1 (Group A) -Reproductive Biology (THEORY)

Reproductive Biology		
	4 Credits	**Class**
Unit 1: Reproductive Endocrinology		**10**
Gonadal Hormones, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female) Reproductive system: Development and differentiation of gonads		
Unit 2: Functional anatomy of male reproduction		14
Histoarchitechture of testis in human; Androgen synthesis		
Unit 3: Functional anatomy of female reproduction		18
Histoarchitechture of ovary in humanSteroidogenesis Reproductive cycles (human) and their regulation, fertilization; Hormonal control of implantation; Mechanism of parturition and its hormonal regulation; Lactation and its regulation		
Unit 4: Reproductive Health		8
Infertility in male and female: causes, diagnosis and management Assisted Reproductive Technology: in vitro fertilization, IUI Modern contraceptive technologies		
Reference Books		
► Ross & Pawlina. Histology: A text and Atlas. 6th edition. ► Guyton & Hall. Medical Physiology. 11th edition. ► Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd. ► Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.		

58. DSE Paper 1 (Group A) -– Reproductive Biology (Lab)

Reproductive Biology	
	2 Credits
List of Practicals	
1. Report on animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals. 2. Tissue fixation, embedding in paraffin, microtomy and slide preparation of endocrine gland (protocol only) 3. Identification of histological sections from photomicrographs of rat/human: testis, epididymis, ovary, fallopian tube, uterus (proliferative and secretory stages)	

59. DSE Paper 1 (Group B) –Endocrinology (THEORY)

Endocrinology		
	4 Credits	**Class**
Unit 1: Introduction to Endocrinology		4
Classification, Characteristic of Hormones		
Unit 2: Epiphysis, Hypothalamo-hypophysial Axis		16
Secretions and their functions of pineal gland in biological rhythms Hormones and their functions of Piptiutary gland, Disorders of pituitary gland.		
Unit 3: Peripheral Endocrine Glands		16
Hormones of Thyroid gland, Adrenal, Pancreas, Ovary, Testis and their functions Hormones in glucose homeostasis, Disorders of endocrine glands		
Unit 4: Regulation of Hormone Action		14
Estrous cycle in rat and menstrual cycle in human Multifaceted role of Vasopressin & Oxytocin.		
Reference Books		
► Guyton and Hall. Textbook of Medical Physiology. 13th Edition ► Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins. ► Vertebrate Endocrinology by David O. Norris,		

60. DSE Paper 1 (Group B) -–Endocrinology Lab

Endocrinology	
	2 Credits
List of Practical	
1. Demonstration of Endocrine glands in rat (through photographs)**.** 2. Identification of the permanent slides of all the endocrine glands (from photographs)**.** 3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of endocrine gland (Protocol)	

61. DSE Paper 2 (Group A) -Animal Behaviour and Chronobiology (THEORY)

Animal Behaviour and Chronobiology		
	4 Credits	**Class**
Unit 1: Introduction to Animal Behaviour		5
Brief contributions of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen		
Unit 2: Patterns of Behaviour		6
Individual Behavioural patterns; Instinct vs. Learnt Behaviour; classical and operant conditioning, Imprinting.		
Unit 3: Social and Sexual Behaviour		15
Social Behaviour: Communication: Chemical communications in insects Altruism; Reciprocal altruism and Kin selection. Sexual Behaviour: Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice)		
Unit 4: Biological Rhythm		14
Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.		
Reference Books		
► Animal Behaviour by Drickamar. ► John Alcock, Animal Behaviour, Sinauer Associate Inc., USA. ► Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA. ► Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA ► Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA ► Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.		

62. DSE Paper 2 (Group A) –Animal Behaviour and Chronobiology (Lab)

Animal Behaviour and Chronobiology	
	2 Credits
List of Practical	

1. To study the aggressive behavior of fish. (from photographs)
2. To study the learning behavior of rat, (from hypothetical data)
3. Submission of a report on behavioral activities of any animal in Forest

63. DSE Paper 2 (Group B) – Wild Life Conservation and Management (THEORY)

Wild Life Conservation and Management		
	4 Credits	**Class**
Unit 1: Introduction to Wild Life		6
Importance of conservation; Causes of depletion;		
Unit 2: Evaluation and management of wild life		8
Habitat analysis, Physical parameters: Soil and water Biological Parameters: food, cover, forage, Standard evaluation procedures: remote sensing and GIS.		
Unit 3: Management of habitats		6
Setting back succession; Grazing logging; Advancing the successional process; Preservation of general genetic diversity Restoration of degraded habitats		
Unit 4: Population estimation		12
Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Pug marks and census method.		
Unit 5: Aims and objectives of wildlife conservation		6
Wildlife conservation in India- in-situ conservation and ex-situ conservation: necessity for wildlife conservation		
Unit 6: Management planning of wild life in protected areas		5
Eco tourism / wild life tourism in forests		
Unit 7: Man and Wildlife		3
Causes and consequences of human-wildlife conflicts		
Unit 8: Protected areas		4
National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.		

Reference Books

- Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
- Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
- Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.
- Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
- 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.

64. DSE Paper 2 (Group B) –Wild Life Conservation and Management (Lab)

Wild Life Conservation and Management	
	2 Credits

List of Practical

1. Submission of a report on mammalian fauna/ avian fauna/ herpeto-fauna of any protected area of North Bengal.
2. Knowledge of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Identification of animals through pug marks, hoof marks, nest, antlers, (photograph)

(OUT OF TWO GROUPS OF DSE PAPER 2 STUDENTS HAVE TO SELECT ANY ONE GROUP)

ZOOLOGY PROGRAMME

CBCS SYLLABUS (2020)

SCHEME AND SYLLABUS UNDER

CHOICE BASED CREDIT SYSTEM

B.Sc. Programme Course WITH

ZOOLOGY

	CORE COURSE (12)	**Ability Enhancement Compulsory Courses AEC (2)**	**Skill Enhancement Courses SEC (4)**	**Discipline Specific Elective DSE (4)**
I	DSC- Botany I DSC- Zoology I DSC- Chemistry I	AECC1		
II	DSC- Botany II DSC-Zoology II DSC- Chemistry II	AECC2		
III	DSC- Botany III DSC-Zoology III DSC- Chemistry III		SEC-I Paper-1	
IV	DSC- Botany IV DSC-Zoology IV DSC- Chemistry IV		SEC-I Paper-2	
V			SEC-II Paper-1	DSE-Botany I DSE-Zoology I DSE-Chemistry I
VI			SEC-II Paper-2	DSE-Botany II DSE-Zoology II DSE-Chemistry II

Discipline Core Courses: Zoology

1. Animal Diversity (SEM I)
2. Comparative Anatomy and Developmental Biology of Vertebrates (SEM II)
3. Physiology and Biochemistry (SEM III)
4. Genetics and Evolutionary Biology (SEM IV)

Skill Enhancement Courses: Zoology

1. Apiculture (SEM III, V)
2. Aquarium Fish Keeping (SEM III, V)
3. Sericulture (SEM IV, VI)
4. Medical Diagnostics (SEM IV, VI)

Discipline Specific Electives: Zoology (Any two)

1. Animal Biotechnology (SEM V)
2. Applied Zoology (SEM V)
3. Aquatic Biology (SEM V)
4. Immunology (SEM VI)
5. Reproductive Biology (SEM VI)
6. Insect,Vector and Diseases (SEM VI)

SEMESTER-I

DSC-Paper I ANIMAL DIVERSITY

THEORY **(CREDITS 4)**

Unit 1: Kingdom Protista **4**
General characters and classification up to classes; locomotion in *Amoeba*

Unit 2: Phylum Porifera **3**
General characters and classification up to classes; Canal System in *Sycon*

Unit 3: Phylum Cnidaria **3**
General characters and classification up to classes

Unit 4: Phylum Platyhelminthes **3**
General characters and classification up to classes; Life history of *Taenia solium*

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

Unit 6: Phylum Annelida **3**
General characters and classification up to classes

Unit 7: Phylum Arthropoda **5**
General characters and classification up to classes; Metamorphosis in Insects

Unit 8: Phylum Mollusca **4**
General characters and classification up to classes

Unit 9: Phylum Echinodermata **4**
General characters and classification up to classes; Water-vascular system in *Asterias*

Unit 10: Protochordates **2**
General features of Protochordata

Unit 11: Agnatha **2**
General features of Agnatha

Unit 12: Pisces **4**
General features and Classification up to class

Unit 13: Amphibia **4**

General features and Classification up to living orders; Parental care

Unit 14: Reptiles **4**

General features and Classification up to living orders; Poisonous and non-poisonous snakes,

Unit 15: Aves **5**

General features; Flight adaptations in birds

Unit 17: Mammals **5**

General features

Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

ANIMAL DIVERSITY

PRACTICAL **(CREDITS 2)**

1. Study of the following specimens: (from photograph)
Amoeba, *Paramecium*, *Sycon*, *Aurelia*, *Taenia solium*, Male and female *Ascaris lumbricoides*, *Pheretima*, *Hirudinaria*, *Limulus*, *Pila*,, *Loligo*, *Sepia*, *Octopus*, *Pentaceros*, *Echinu* and *Antedon*, *Balanoglossus*,
Branchiostoma, *Petromyzon*, *Sphyrna Torpedo*, *Labeo*, *Ichthyophis*, *Salamandra*, *Hyla*, *Chelone*, *Chamaeleon*, *Draco*, *Vipera*, *Naja*, *Crocodylus*, Bat

2. Study of the following permanent slides: (from photograph)
T.S. and L.S. of *Sycon*, T.S. of Male and female *Ascaris*

3. Key for Identification of poisonous and non-poisonous snakes

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

SUGGESTED READINGS

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

SEMESTER-III

DSC Paper 3- PHYSIOLOGY AND BIOCHEMISTRY

THEORY **(CREDITS 4)**

Unit 1: Nerve and muscle **8**

Structure of a neuron, Resting membrane potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle

Unit 2: Digestion **5**

Physiology of digestion of carbohydrates, proteins,

Unit 3: Respiration **5**

Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion **5**

Structure of nephron, Mechanism of Urine formation,

Unit 5: Cardiovascular system **6**

Composition of blood,Structure of Heart, Cardiac cycle

Unit 6: Endocrine Glands **7**

Structure and function of pituitary, thyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism **8**

Glycolysis, Krebs cycle, Review of electron transport chain

Unit 8: Lipid Metabolism 5

β oxidation of palmitic acid

Unit 9: Protein metabolism **5**

Urea Cycle

Unit 10: Enzymes

Mechanism of action, **6**

PHYSIOLOGY AND BIOCHEMISTRY

PRACTICAL **(CREDITS 2)**

1. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland (from photograph)
2. Identification of permanent slides of ileum, liver, lung, kidney (from photograph)
3. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose) (Only principle and reactions involved)

SUGGESTED READINGS

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

SEC 1 Paper-1 (Group A)-APICULTURE (Theory)

(CREDITS 2)

Unit 1: Biology of Bees	**2**
Classification and Life cycle of Honey Bees	
Unit 2: Rearing of Bees	10
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Selection of Bee Species for Apiculture	
Unit 3: Diseases and Enemies	5
Bee Diseases Control and Preventive measures	
Unit 4: Bee Economy	2
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc	

***Submission of a report on apiary/modern bee industry (20 marks)**

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, NewDelhi.

SEC 1 Paper-1 (Group B)-AQUARIUM FISH KEEPING (Theory)

(CREDITS 2)

Aquarium Fish Keeping		
	2 Credits	**Class**
Unit 1: Introduction to Aquarium Fish Keeping		**2**
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 such as Guppy, Molly, Gold fish, Angel fish		
Unit 3: Food and feeding of Aquarium fishes		7
Use of live fish feed organisms. Preparation and composition of formulated fish feeds,		
Unit 4: Fish Transportation		3
Live fish transport - Fish handling, packing and forwarding techniques.		

- **Submission of a report on Aquarium maintenance (20 marks)**

Reference Books:

- Anshuman D. Dholakia. 2016. Ornamental Fish Culture and Aquarium Management. Astral International.
- Harishanker J. Alappat;A. 2011. Biju Kumar. Aquarium Fishes: A Colourful Profile. BR Publishing Corporation
- Sarij K. Swain, N. Sarangi and S. Ayyappan. 2010. Ornamental Fish Farming. Indian Council of Agricultural Research.

(OUT OF TWO GROUPS OF SEC1 PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEMESTER-V

DSE Paper-1 (Group A)- ANIMAL BIOTECHNOLOGY

THEORY **(Credits 4)**

Unit 1: Molecular Techniques in Gene manipulation **24**

Cloning vectors: Plasmids

Restriction enzymes: Nomenclature, types

Construction of genomic and cDNA libraries

DNA sequencing: Sanger method, Polymerase Chain Reaction

Unit 2: Genetically Modified Organisms **18**

Production of cloned and transgenic animals: Nuclear Transplantation,

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs

Unit 3: Culture Techniques and Applications **10**

Animal cell culture, Molecular diagnosis of genetic diseases (Sickle cell anemia)

PRACTICAL **(Credits 2)**

1. To study following techniques through photographs
   a) Southern Blotting
   b) Northern Blotting
   c) Western Blotting
   d) DNA Sequencing (Sanger's Method)
   e) PCR
   f) DNA fingerprinting
2. Project report on animal cell culture

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis.* II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics.* V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y., USA.
- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics.* VI Edition, Oxford University Press.

DSE Paper-1 (Group B**) APPLIED ZOOLOGY**

THEORY **(CREDITS 4)**

Unit 1: Introduction to Host-parasite Relationship **3**
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Parasitic Protozoa **8**
Life history and pathogenicity of *Plasmodium vivax*

Unit 3: Parasitic Helminthes **5**
Life history and pathogenicity of *Taenia solium*

Unit 4: Insects of Economic Importance **8**
Biology, Control and damage caused by *Heloveltis theivora, Sitophilus oryzae*

Unit 5: Insects of Medical Importance **8**
Medical importance and control of *Anopheles, Aedes,*

Unit 6: Animal Husbandry **5**
Preservation and artificial insemination in cattle;

Unit 7: Poultry Farming **5**
Principles of poultry breeding, Management of breeding stock and broilers

Unit 8: Fish Technology **5**
Concept of monoculture, polyculture, pen culture, cage culture, Induced breeding

PRACTICAL **(CREDITS 2)**

1. Identification of *Plasmodium vivax, Trypanosoma gambiense,* and *Wuchereria bancrofti* and any of their life stages through photomicrographs or specimens.
2. Identification of arthropod vectors associated with human diseases: *Culex, Anopheles, Aedes*
3. Identifying feature (through photograph) and economic importance of *Helicoverpa* (*Heliothis*) *armigera, Papilio demoleus, Sitophilus oryzae*
4. Submission of report on poultry farm/ animal breeding centre

SUGGESTED READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia,* Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR).
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals.* Lea & Fabiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

DSE Paper-1 (Group C**) AQUATIC BIOLOGY**

THEORY **(Credits 4)**

Unit 1: Aquatic Biomes	**10**

Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone

Unit 2: Freshwater Biology	20

Lakes: Lake as an Ecosystem, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen).

Unit 3: Marine Biology	10

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

Unit 4: Management of Aquatic Resources	10

Causes of pollution: Agricultural, Industrial, Sewage, and Oil spills, Eutrophication, Sewage treatment Water quality assessment- BOD and COD.

PRACTICAL **(CREDITS 2)**

List of Practical

1. Identification of the important zooplanktons present in a pond ecosystem. (from photograph)
2. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance (from photograph).

SUGGESTED READINGS

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

(OUT OF THREE GROUPS OF DSE PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)

SEC 2 Paper-1 (Group A)-APICULTURE (Theory)

(CREDITS 2)

Unit 1: Biology of Bees	**2**
Classification and Life cycle of Honey Bees	
Unit 2: Rearing of Bees	10
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Selection of Bee Species for Apiculture	
Unit 3: Diseases and Enemies	5
Bee Diseases Control and Preventive measures	
Unit 4: Bee Economy	2
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc	

***Submission of a report on apiary/modern bee industry (20 marks)**

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, NewDelhi.

SEC 2 Paper-1 (Group B)-AQUARIUM FISH KEEPING (Theory)

(CREDITS 2)

Unit 1: Introduction to Aquarium Fish Keeping	**2**
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 such as Guppy, Molly, Gold fish, Angel fish	
Unit 3: Food and feeding of Aquarium fishes	7
Use of live fish feed organisms. Preparation and composition of formulated fish feeds,	
Unit 4: Fish Transportation	3
Live fish transport - Fish handling, packing and forwarding techniques.	

- **Submission of a report on Aquarium maintenance (20 marks)**

(OUT OF TWO GROUPS OF SEC2 PAPER 1 STUDENTS HAVE TO SELECT ANY ONE GROUP)