

CBCS SYLLABUS

FOR

POST-GRADUATE COURSES

SUBJECT-ZOOLOGY

SUBMITTED BY

UNIVERSITY DEPARTMENT OF ZOOLOGY

B.R.A.B.U. MUZAFFARPUR

SEMESTER - I

Core Course (CC-1): Functional Biology of Invertebrates and Chordates Full Marks - 70
Time: 3 hrs

- Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 3 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit - I

- 1.1 Organization of coelom and its significance
- 1.2 Patterns of feeding and digestion in invertebrates
- 1.3 Invertebrate larvae: Types and significance

Unit - II

- 2.1 Respiratory pigments in different phylogenetic groups
- 2.2 Organs of Respiration in Invertebrates: Gills, Lungs and Tracheae
- 2.3 Mechanism of Respiration in Invertebrates

Unit - III

- 3.1 Organs of respiration in vertebrates: Gills, ARO and Lungs
- 3.2 Principles of gaseous exchange and Fick's modified equation
- 3.3 Transport of gases in blood and body fluid
- 3.4 Regulation of respiration (Neural and chemical control)
- 3.5 Respiratory adaptations at higher altitudes and in diving mammals

Unit - IV

- 4.1 Patterns of nitrogenous excretion in different phylogenetic groups
- 4.2 Organs of excretion: Coelomoducts, nephridia, malpighian tubules and Kidney
- 4.3 Mechanism of osmoregulation and excretion in aquatic (freshwater and marine) and terrestrial animals
- 4.4 Mechanism of acid-base balance

Unit - V

- 5.1 Thermoregulation in vertebrates
- 5.2 Mechanism of energetic of muscle contraction (Skeletal)
- 5.3 Physiology of electrical and synaptical transmitters in neurons
- 5.4 Neurotransmitters and their functions
- 5.5 Acoustico-lateral system and electroreception in aquatic vertebrates

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SEMESTER - I

Core Course (CC- 2): Molecular Cell Biology

Full Marks - 70

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit I:

(A) Bio membrane

- 1.1 Molecular composition, arrangement and functional consequences
- 1.2 Models of bio-membrane
- 1.3 Transport across bio-membrane: diffusion, active transport and membrane pumps (P-type pump, V-type pump and ABC transporter)
- 1.4 Cotransport by symporters and antiporters

(B) Cytoskeleton

- 1.5 Microtubules and microfilaments: Structure and dynamics
- 1.6 Role of Kinesin and Dynein in intracellular transport
- 1.7 Axonal transport and cell movement (with respect to non-muscle motility)

Unit II: DNA replication

- 2.1 Outline of prokaryotic replication
- 2.2 Replication features of single stranded phages
- 2.3 Mechanism and machinery of replication in eukaryotes
- 2.4 DNA damage and repair mechanisms

Unit III: Transcription

- 3.1 Outline mechanism of prokaryotic transcription
- 3.2 Organization of eukaryotic transcription machinery
- 3.3 General and specific transcription factors
- 3.4 Regulatory elements & DNA binding domains of transcription apparatus
- 3.5 Processing of primary transcript & RNA editing in eukaryotes

Unit IV: Translation

- 4.1 Genetic code: Codon assignment and features
- 4.2 Outline of Prokaryotic translation
- 4.3 Eukaryotes translation: machinery (Ribosome & tRNA)
- 4.4 Eukaryotes translation: mechanism (Initiation, elongation and termination)

Unit V: Intra cellular protein trafficking:

- 5.1 Targeting proteins to ER: Signal hypothesis
- 5.2 Co- and post - translational modifications of proteins
- 5.3 Trafficking mechanisms:
 - (a) Vesicular transport
 - (b) Protein sorting
 - (c) Endocytosis and exocytosis

SEMESTER - I

Core Course (CC- 3): Genetics

Full Marks - 70

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit I: Organization of Chromosomes

- 1.1 Organization of prokaryotic chromosomes
- 1.2 Organization of eukaryotic chromosomes: Nucleosome as functional particle, 30 nm chromatin fibre, higher order structure of chromatin
- 1.3 Organization of centromere and kinetochores, Organization of telomere and its maintenance
- 1.4 Heterochromatin: Types, organization, formation and significance
- 1.5 Structural organization and functional significance of Polytene and Lampbrush chromosomes.

Unit II: Microbial genetics

- 2.1 Transformation, conjugation, transduction and sex-duction in bacteria
- 2.2 Construction of linkage map in bacteria
- 2.3 Molecular mechanism of recombination

Unit III: Cell cycle

- 3.1 Stages and check points in cell cycle
- 3.2 Genetics of cell cycle regulation: Role of cyclins and CDKs
- 3.3 Molecular basis of cellular check points

Unit IV: Sex determination and dosage compensation

- 4.1 Genetic and Molecular basis of sex determination in *Caenorhabditis elegans*, *Drosophila* & human
- 4.2 Genetic basis of dosage compensation in *Caenorhabditis elegans*, *Drosophila* & mammals

Unit V: Techniques & Methods in genetics

- 5.1 DNA sequencing: Maxam & Gilbert Method, Sanger's Dideoxycy Method and chain termination method and automated sequencing, pyro-sequencing and whole genome short-gth sequencing.
- 5.2 DNA amplification: Polymerase chain reaction, its application and limitations.
- 5.3 DNA finger printing: VNTR profiling, STR profiling (Autosomal & Y Chromosome), mitochondrial DNA profiling and SNP profiling
- 5.4 Genome expression analysis: Southern, Northern & Western blotting, Reverse Transcription, PCR, DNA micro array.

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SEMESTER - I

Core Course (CC- 4) Practical

Full Marks - 70 CIA

1st Sitting

1. Squash preparation using any of the following:	10	05
(a) Chromomus/Drosophila larvae for polytene chromosomes		
(b) Onion root tip for mitosis and mitotic index		
(c) Grasshopper testes for meiosis and related features		
2. Experimental demonstration (any one of the following):	10	05
(a) Enumeration of RBC		
(B) Enumeration of WBC (TC and DC)		
(C) Preparation of a histological slide of the given paraffin section/whole mount of an invertebrate larva	05	05
3. Identification and comments upon spots (cytological slides: Nos. 02)	05	05
<u>2nd Sitting</u>		
4. Identification and comments upon spots (Invertebrate slide-03, vertebrate slide-02)	10	05
5. Genetics (any of the following)	10	05
(a) Solving problems on Mendelian principles and sex-linked inheritance		
(b) Preparation of linkage map based on data from Drosophilla crosses and analysis in Neurospora		tetrad
(c) Pedigree analysis in human		
6. Class records, charts/ models & field collection	10	
7. Viva-voce	10	05
	Total	70 30

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SEMESTER – II

Core Course (CC- 5): Environmental Science

Full Marks – 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit I: Concept and Dynamics of ecosystem

- 1.1 Abiotic factors and Biotic factors.
- 1.2 Energy flow
 - (a) Lindeman's rule of trophic dynamics
 - (b) Energy flow models
- 1.3 Biogeochemical cycles: Nitrogen, Carbon, Sulphur and Phosphorous cycle
- 1.4 Hydrological cycles.

Unit II: Principles pertaining to limiting factors

- 2.1 Liebig's Law of minimum, Shelford's Law of tolerance
- 2.2 Concept & Law of limiting factors
- 2.3 Factors compensation and ecotypes

Unit III: Population Growth, Predation and Regulation

- 3.1 Demography: Life tables, Generation time, Net reproductive rate, Reproductive value
- 3.2 Population growth: Exponential growth, Verhulst-Pearl logistic growth model.
- 3.3 Population regulation extrinsic and intrinsic mechanisms
- 3.4 Concept of niche, niche width and overlap, fundamental and realized niche, resource partitioning character displacement

Unit IV: Global Environmental Issues

- 4.1 Climate Change
- 4.2 Carbon Footprint
- 4.3 Water Security – conservation of surface and ground water
- 4.4 Wildlife conservation
 - (a) Causes of extinction
 - (b) National and International efforts for conservation (CITES, IUCN, CBD)
 - (c) National parks and sanctuaries
 - (d) Biosphere reserves
 - (e) Wildlife protection Acts

Unit V: Pollution Biology

- 5.1 Pollutants, their sources and classification
- 5.2 Causes, effects and control of Water and Air Pollution
- 5.3 Eutrophication and Intropication
- 5.4 Environmental Radioactive pollution
- 5.5 Emerging pollutants: POPs, Pharmaceuticals
- 5.6 Bio-indicators as index of pollution and their significance

SEMESTER – II

Core Course (CC-6) Bio-Instrumentation & Biostatistics

Full Marks – 70

Time – 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 3 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit – I

- 1.1 Principles and uses of analytical instruments – pH meter, colorimeter, Spectrophotometer, Ultra-centrifuge.
- 1.2 Microscopy – Principles of light, Transmission Electron, Scanning Electron, Fluorescence, Phase-contrast and Confocal Microscopes Photomicrography.

Unit – II

- (A) Separation techniques
1. Electrophoresis: SDS PAGE, Agarose gel electrophoresis
 2. Chromatography: Column, GLC, HPLC
 3. Organic separation by centrifugation
 4. Cell separation by flow cytometry and density gradient centrifugation
- (B) Immunological techniques
1. Radio- immunoassay (RIA)
 2. Enzyme-linked immunosorbent assay (ELISA)

Unit – III

- 4.1 Basic concepts in Biostatistics (sampling design, data collection and scaling techniques)
- 4.2 Mean: Arithmetic, Geometric & Harmonic Mean
- 4.3 Standard Deviation
- 4.4 Standard Error
- 4.4 Analysis of Variance (ANOVA)

Unit-IV

1. Correlation (Karl Pearson and Rank's correlation)
2. Regression

Unit – V

- 5.1 Rules of probability
- 5.2 Binomial probability distribution
- 5.3 Poisson probability distribution
- 5.4 Normal probability distributions
- 5.5 Test of Significance
 - (a) Chi-square test
 - (b) Student's t-test

SEMESTER – II

Core Course (CC- 7): Biochemistry

Full Marks – 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (four to be answered) of 5 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit-I: Bioenergetics

- 1.1 Laws of thermodynamics, internal energy, enthalpy, entropy
- 1.2 Concept of free energy, redox potential, energy rich compounds
- 1.3 Mitochondrial electron transport chain and oxidative phosphorylation

Unit-II: Biochemistry of Carbohydrates

- 2.1 Monosaccharides and Disaccharides, Types and properties
- 2.2 Polysaccharides: Homopolysaccharide and Heteropolysaccharide
- 2.3 Glycolysis, HMP shunt, Glycogenesis and Glycogenolysis

Unit-III: Biochemistry of proteins and lipids

- 3.1 Primary, secondary, tertiary, quaternary and domain structures
- 3.2 Stabilizing forces in protein structure
- 3.3 Peptide conformation (Ramachandran plot, helices, turns and sheets)
- 3.4 Biosynthesis of Urea
- 3.5 Free fatty acids: Synthesis and importance
- 3.6 β -Oxidation of long chain fatty acids

Unit – IV: Enzyme Biochemistry

- 4.1 Enzyme: Classification and nomenclature
- 4.2 Mechanism of enzyme action
- 4.3 Kinetics of enzyme catalyzed reaction
- 4.4 Non-genetic Regulation of enzyme activity:
 - (a) Feedback inhibition
 - (b) Allosteric inhibition
- 4.5 Free radicals, Antioxidants and detoxification

Unit – V: Principles of Histology and Histochemistry

- 5.1 General principles of fixation and types of fixatives
- 5.2 General principles of staining and types of dyes
- 5.3 General principles of histochemistry:
 - (a) Carbohydrate
 - (b) Protein
 - (c) Lipid
 - (d) Nucleic acids
 - (e) Enzymes

SEMESTER – II

Core Course (CC- 8): **Biosystematics and Evolution**

Full Marks – 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (four to be answered) of 3 marks each. Part C will consist of five questions (three to be answered) of 10 marks each.

Unit 1: Biosystematics

1. Definition & basic concept of Biosystematics and taxonomy, its importance and application in biology.
2. Hierarchy of categories, outline of classification of animals, important criteria used for classification up to Classes in each phylum
3. Species concept : Biological and phylogenetic, sub - species and other intra-specific categories, evolutionary relationship among taxa
4. International code of Zoological nomenclature (ICZN): operative principles, and important rules, Zoological nomenclature and scientific names of various taxa
1. Trends in taxonomy : Chemo - taxonomy, cyto - taxonomy and molecular taxonomy

Unit 2: Pattern of genetic variation and natural selection

1. Genetic polymorphisms, variation in chromosome structure, protein structure and nucleotide sequences
1. Concept of Natural Selection (Darwinian and neo-Darwinian), mode of its operation: stabilizing, directional and disruptive modes of Natural Selection

Unit 3: Molecular evolution

1. Variation in the evolution of protein and DNA sequences
2. Molecular phylogenies
3. Rates of molecular evolution and molecular clock
4. Neutral theory of molecular evolution
5. Origin of new genes and evolution of multi gene family

Unit 4: Mechanism of speciation

1. Patterns and mechanisms of reproductive isolation and its role in evolution
2. Models of speciation : sympatric and allopatric

Unit 5: Population genetics

1. Concept of Gene pool, allele frequency and genotype frequency
2. Hardy-Weinberg principle of genetic equilibrium and its mathematical derivation
3. Detailed account of destabilizing forces of genetic equilibrium: Natural selection, Mutation, Migration, Meiotic drive, and Genetic Drift

SEMESTER - II

Course (CC-9) Practical	First Sitting	Full Marks - 70,	CIA - 30
1. Biochemical experiments (any one of the following) (a) Determination of salivary amylase activity (b) Colorimetric estimation of glucose, urea, uric acid or albumen in a given sample (c) Separation of amino acids by paper chromatography (d) Biochemical detection of glucose, starch, protein or lipid in a given sample		10	05
2. Identify and comment upon the spots of evolutionary significance (any one of the following) (a) Archaeopteryx (b) Darwin's finches (c) Serial homology in cephalothoracic appendages in prawn (d) Homology in Anology (e) Adaptive radiation in beaks of birds		10	05
3. Histochemistry; Histochemical demonstration involving the following reagents: PAS, Alvan Blue, Sudan Black B, Sudan III/IV, Fastgreen, Methyl green- Pyronin, Mercuric bromophenol or Preparation of temporary mount of any two of the specimens of plankton	Second Sitting	10	05
4. Environmental studies (any one of the following) (i) Measurement of pH (ii) Estimation of dissolved O ₂ (iii) Estimation of free CO ₂ (iv) Estimation of carbonate & bicarbonate alkalinity (v) Composition & assessment of the taxonomic diversity/biodiversity in a habitat (of grassland, pond & wetland) (vi) Estimation of the total hardness		10	05
5. Statistics: Standard deviation, standard error, correlation, regression, t-test		10	05
6. Class record		10	
7. Viva-voce		10	05

Date: _____

SEMESTER - III

Core Course (CC-10): Vertebrate Immunology

Fall Marks - 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (four to be answered) of 5 marks each. Part C will consist of five questions (three to be answered) of 10 marks each.

Unit 1: Innate and Acquired Immunology

1. Cell types of innate and adaptive immunity, Lymphocyte trafficking
2. Phagocytosis and inflammation
3. Humoral immunity; β cell activation and differentiation, primary and secondary humoral response
4. Cell mediated immunity; T - cell development and T-cell activation, CTL and NK cell mediated immunity

Unit 2: (A) Nature of Antigens

1. Antigenicity and immunogenicity, and the factors influencing it.
2. Characteristics of β and T cell epitopes and haptens
3. Super antigen and its role in T cell activation
4. Antigen processing and presentation
5. MHC complex

(B) Structure and functions of Antibodies

- (a) Gross and fine structure
- (b) Classes and sub-classes
- (c) Antibody mediated effector functions and monoclonal antibodies

Unit 3: (A) Antigen- antibody interaction and Complement system

1. Antibody affinity and antibody avidity
 2. Precipitation reactions
 3. Agglutination reactions
 4. Complement System - activation pathway, biological function and complement deficiencies
 5. ELISA
- (B) Cytokines : Classification and function, Cytokines receptors.

Unit 4: Organization and expression of Ig genes

1. Organization of Ig genes
2. Generation of antibody diversity
3. BCR and Generation of T-cell receptor diversity

Unit 5: Immunology and Diseases

1. Hypersensitivity (Type I, II, III, IV).
2. Auto-immunity
3. Immune responses to infectious agents - bacterial, viral and parasitic infection (Protozoa and Helminth parasites).
4. Immunodeficiencies

SEMESTER – III

Core Course (CC- III): Gamete and Developmental Biology

Full Marks – 20

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 3 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit-I: Gamete Biology

- 1.1 Cellular basis of spermatogenesis and Biochemistry of semen
- 1.2 Ovarian follicular growth and differentiation
- 1.3 Oogenesis and vitellogenesis
- 1.4 Ovulation and oviduct transport
- 1.5 Molecular events during fertilization

Unit II: (A) Multiple ovulation and Embryo transfer technology in human being

- 2.1 In vitro oocyte maturation
 - 2.2 Super ovulation
 - 2.3 In vitro fertilization
- #### (B) Assisted Reproduction technologies
- 2.4 Collection and preservation of gametes
 - 2.5 IVF, GIFT & Immuno - contraception

Unit III: Basic concept of development

- 3.1 Potency, commitment, specification, induction, competence, determination and differentiation
- 3.2 Morphogenetic gradients, cell fate and cell lineages, genomic equivalence and cytoplasmic determinants.

Unit IV: Differentiation, morphogenesis and organogenesis

- 4.1 Cell differentiation: Role of cytoplasm and nucleus
- 4.2 Gene amplification and rearrangement during development
- 4.3 Axes and pattern formation in *Drosophila*.
- 4.4 Limb development and regeneration in vertebrates

Unit V: Stem cell Biology

- 5.1 Definition and characteristics of stem cell
- 5.2 Type of stem cell (embryonic, adult and cancer stem cell)
- 5.3 Nuclear reprogramming of induced pluripotent stem cell, test for pluripotency
- 5.4 Potential application of stem cells, therapeutic cloning

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SEMESTER – III

Core Course (CC- 12): Vertebrate Endocrinology

Marks – 70

Full

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (four to be answered) of 3 marks each. Part C will consist of five questions (three to be answered) of 10 marks each.

Time: 3 hrs.

Unit-I

- 1.1 Aims and scope of endocrinology
- 1.2 Hormones as messengers
- 1.3 Chemical nature and gross features of hormones
- 1.4 Neuro-endocrine system and neurosecretion
- 1.5 Hypothalamic control of endocrine system

Unit-II

- 2.1 Hormones involved in reproduction
 - (a) Seasonal breeders
 - (b) Continuous breeders
- 2.2 Hormonal regulation of reproductive cycle
 - (a) Ovarian cycle
 - (b) Menstrual cycle
 - (c) Oestrus cycle

Unit-III

- 3.1 Biosynthesis of steroid hormones
- 3.2 Biosynthesis of amino acid derived hormones (T₄, Epinephrine)
- 3.3 Biosynthesis of simple peptide hormones, Piv and Prohormones.

Unit-IV Hormone Receptors:

- 4.1 β -adrenergic receptor
- 4.2 Insulin receptor
- 4.3 Steroid hormone receptor

Unit-V: General principles of hormone actions (signal transduction)

- 5.1 Second messenger concept (G proteins, Nucleotides (cAMP, cGMP), Calcium, Calmodulin, Phospholipids)
- 5.2 Lipid soluble hormones and intracellular receptor
- 5.3 Lipid insoluble hormone and intracellular signalling

SEMESTER – III

• Core Course (CC- 12): Animal Behaviour

Full Marks – 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five questions (three to be answered) of 10 marks each.

Time: 3 hrs.

Unit-I: Basics of Animal Behaviour

1.1 Ethology- Definition, Branches, Significance

1.2 Approaches and methods in the study of Behavior

1.3 Patterns of Behavior-

(a) Innate behavior- Kinesis/ Taxes, Simple reflex, Comparison of reflex and complex behaviors, Instinct and Motivation

(b) Learned behavior- Habituation, Imprinting, Conditioned reflex, Trial & error learning, Reinforcing and Cognition

Unit II: Social Behavior

2.1 Social behavior of insects (Honey bees, Ants and termites)

2.2 Schooling in fish, Flocking in birds,

2.3 Social organization of Primates

2.4 Parental care in fishes

2.5 Altruism: Reciprocal altruism, Inclusive fitness, group selection, and Kin – selection

Unit III: Reproductive Behavior

3.1 Evolution of sex and reproductive strategies

3.2 Mating system

3.3 Courtship & Parental Behaviors: Parental care and parental investment

Unit IV, Biological Rhythms

4.1 Circadian, Circannual, Lunar, Tidal and Epicycles

4.2 Navigation including orientation

4.3 Migration of Fishes and Birds

Unit V: Control of Behavior

5.1 Neural control of Behaviour

5.2 Hormones and Behavior

5.3 Ecological aspects of behavior: Habitat selection, Optimal foraging theory, and Aggressive behavior

SEMESTER - III

Core Course(CC- 14) Practical

Time : 6 hrs

Full marks - 70 CIA-30

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|---|-------|
| 1. Any one of the immunological experiments
(a) Determination of blood group using ABO antisera
(b) Preparation of blood film and identification of blood cells of immunological importance
(c) Hormonal assessment of T/T esterase/estrogen by ELISA reader | 10 05 |
| 2. Identify and comment upon the given spots
(a) Endocrinological slides-01
(b) Embryological slides -02 | 10 05 |
| 3. Prepare a permanent mount of chick embryo or
Identify and comment upon the exposed endocrine glands in a mammal | 10 05 |
| 4. Comment upon the behavioural aspects of specimens provided
(any two)
(a) Parental care (Elipposampus, Cichlids, Alytes, Hyla, Ichthyophis)
(b) Caste system (Honey bee/termites/ants) and its significance
(c) Dance as means of communication in honey bees | 10 05 |
| 5. Identification and comment upon the given embryonic stages
(any two) | 10 05 |
| 6. Class record | 10 05 |
| 7. Viva voce | 10 |

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List of Elective Courses (EC):

- (1) Cell and Molecular Biology (EC-1A & 2A)
- (2) Fish and Inland Fisheries (EC-1B & 2B)
- (3) Environmental Biology (EC-1C & 2C)
- (4) Entomology (EC-1D & 2D)
- (5) Parasitology (EC-1E & 2E)
- (6) Cytogenetics (EC-1F & 2F)
- (7) Comparative Endocrinology (EC-1G & 2G)

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SEMESTER – IV

EC - 1A Elective paper : Cell and Molecular Biology

Full Marks – 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 3 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit I: (A) Regulation of gene expression in bacteria

- 1.1 Inducible system: Lac operon with negative control and Positive control (CAP/cAMP regulation)
- 1.2 Repressible system: Tryptophan operon and mechanism of attenuation in *E. coli* & *B. subtilis*
- 1.3 The arabinose operon

(B) Levels of gene regulation in eukaryotes

- 1.4 Transcriptional control involving chromatin remodelling and genome imprinting
- 1.5 Post - transcriptional control involving alternate poly-adenylation and alternate splicing
- 1.6 Translational control involving Ribosome selection, translation inhibition, mRNA degradation and gene silencing (RNA interference)

Unit II: (A) Cancer Biology

- 2.1 Cytology of cancer cells and types of cancer
- 2.2 Genetic basis: Oncogenes and tumour - suppressor genes
- 2.3 Chromosomal anomalies associated with cancer

(B) Apoptosis

- 2.4 Machinery of programmed cell death
- 2.5 Extrinsic and intrinsic pathways
- 2.6 Control of programmed cell death

Unit-III: (A) Nucleus

- 3.1 Functional architecture of interphase nucleus and nuclear envelope
- 3.2 Ultra structure of nucleolus: organization of Rdna
- 3.3 Nucleolar function: synthesis of rRNA, its processing and biogenesis of ribosomes
- 3.4 Mechanism of nuclear cytoplasmic exchange

(B): Cell-cell signaling

- 3.5 Signaling from plasma membrane to nucleus: Type of signal (G protein and protein kinases), target cells and effector organs
- 3.6 Cell surface receptors of signaling molecules
- 3.7 Signal transduction pathways and their regulation
Second messenger system

Unit-IV: (A) Genomics

- 4.1 Functional genomics: Predicting gene and protein function by sequence analysis
- 4.2 Genome organization in humans: The Human Genome Project, main features of human genome

4.3 Gene Therapy Prospect & Application

(B) Recombinant DNA Technology

- 4.4 Tools and techniques (enzymes, vectors, cloning strategies)
- 4.5 Construction and screening of DNA libraries
- 4.6 Application of recombinant DNA technology

Unit-VI Transposable genetic elements and Epigenetics

- 5.1 Discovery and definition: Ac/Ds elements in maize
- 5.2 Prokaryotic elements: insertion sequences and transposons
- 5.3 Retrotransposons and DNA transposons in eukaryotes
- 5.4 Mechanism of transposition (conservative and replicative)

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SEMESTER - IV

EC - 1A Elective paper (Practical): Cell and Molecular Biology
Time: 6 hrs

Full Marks - 70 CIA-30

1st sitting

1.	Cytochemical demonstration of protein/lipid/carbohydrate/nucleic acids	15	05
2.	Vital staining of secretory granules and mitochondria	10	05
3.	Identify and comments up on spots (1-5): Cytological slides	10	05

2nd sitting

4.	Any one of the following:	10	05
(a)	Estimation of sperm count from epididymal wash of laboratory mammals		
(b)	Isolation of DNA and its separation by agarose gel electrophoresis (demonstration)		
2.	Practical records (including slides, charts, model, field work)	05	05
5.	Dissertation and Viva-voce	30	05

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SEMESTER - IV

EC - IB Elective paper : Fish and Inland Fisheries

Full Marks - 70

Time : 3 hrs

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Fish Biology

Unit I: (A) Taxonomy and evolution

- 1.1 Classification of fishes
- 1.2 Origin and evolution of elasmobranch
- 1.3 Origin and evolution of teleost
- 1.4 Crossopterygi: distribution, structure and affinities
- 1.5 Holocephali: structure and affinities

(B) Fish Anatomy

- 1.6 Integument: Structure and function
- 1.7 Alimentary canal & its modification in relation to feeding habit
- 1.8 Apuistio-lateralis system
- 1.9 Air bladder & its modification

Unit II: (A) Fish Physiology

- 2.1 Mechanism of gill respiration
- 2.2 Accessory respiratory organs
- 2.3 Sound production
- 2.4 Excretion and osmoregulation
- 2.5 Reproduction in fish

(B) Fish endocrinology

- 2.6 Pituitary
- 2.7 Thyroid
- 2.8 Adrenal
- 2.9 Corpuscles of Stenka and Hepatopancreas

Applied Fisheries

Unit III: Fresh water Aquaculture

- 3.1 Construction and lay out plan of different types of ponds and their management
- 3.2 Role of physico-chemical and biological factors in aquaculture
- 3.3 Aquatic weeds & their control
- 3.4 Pen & cage culture
- 3.5 collection and transport of fish seeds from riverine resources
- 3.6 Fish food organisms: Types and their culture; supplementary feeding
- 3.7 Pollutants and their effect on fisheries

Unit IV: (A) Fish Pathology

- 4.1 Nutritional diseases
- 4.2 Intrinsic diseases
- 4.3 Bacterial diseases in fish and their control
- 4.4 Fungal and viral diseases in fish and their control
- 4.5 Parasitic diseases in fish and their control

(B) Fish biotechnology

- 4.6 Cryopreservation of fish gamete
- 4.7 Induced Breeding in fish using Carp pituitary extract (CPE) and new generation drugs

- 4.8 Androgenesis, Gynogenesis and transgenic fish
- 4.9 Cytogenetical techniques in aquaculture
- 4.10 Integrated fish farming

Unit V (A) Fisheries resources

- 5.1 Riverine fisheries resources of India
- 5.2 Reservoir fisheries in India
- 5.3 Lacustrine fisheries in India
- 5.4 Estuarine fisheries in India

(B) Post harvest Technology

- 5.5 Principles and methods of inland fishing crafts and gears
- 5.6 Fish spoilage and methods of fish preservation
- 5.7 Fish byproducts
- 5.8 Fish marketing

100
10/10/20

4-5
10-10

SEMESTER – IV

EC – 1B Elective paper (Practical): Fish and Inland Fisheries

Time : 4 hrs

Full Marks – 70

04-20

1st Sitting

- | | | |
|--|------------|----|
| 1. Any one of the following experiments: | 10 | 05 |
| i) O ₂ Consumption in relation to body size | | |
| ii) Hematological analysis (Hb estimation, RBC counting) | | |
| iii) Estimation of pH using pH meter, Dissolved Oxygen, Total alkalinity, Total Hardness | | |
| 2. Spotting: | 5 x 2 = 10 | 05 |
| i) Museum specimen | - 01 | |
| ii) Bones | - 01 | |
| iii) Slides | - 02 | |
| iv) Fishing gear/aquatic weeds | - 01 | |
| 3. Microtomy/paraffin sectioning and permanent slide preparation | 10 | 05 |
| or | | |
| Mounting: scales, olfactory lamella, respiratory epithelium | | |

2nd Sitting

- | | | |
|---|----|----|
| 4. Taxonomic identification of a local available fish up to species level (based upon morphometric- meristic analysis and identification key) | 05 | 05 |
| 5. Any one of the following: | 10 | 05 |
| i) Biological analysis of water including Phytoplankton, Zooplankton, Macrophytes and Zoosarcobenthos. | | |
| ii) Identification of representative fish parasites and their life histories | | |
| iii) Identification of fry and fingerlings of major cultivated species of fresh water fish | | |
| 6. Practical records (including slides/chart/model/field work) | 05 | |
| 7. Dissertation and Viva | 20 | 05 |

$\frac{100}{100} \times \frac{60}{70} = \frac{600}{70} = 8.57$

SEMESTER – IV

EC – 10 Elective paper : Entomology

Time : 3 hrs

Full Marks – 70

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 3 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit I: (A) Classification

- 1.1 Outline of classification of class Insecta upto suborders
- 1.2 Classification upto superfamilies in following economically important groups (Coleoptera, Hemiptera and Lepidoptera, Dipterans)
- 1.3 Origin of insects.

(B) Morphology

- 1.4 General organization of insect body
- 1.5 Comparative study of Antennae and their modification
- 1.6 Comparative study of Mouth parts: structure, modification and function
- 1.7 Comparative study of Legs and their modification
- 1.8 Compound eye: structure including image formation
- 1.9 Wings : Venations and modifications
- 1.10 Integument : Structure and moulting
- 1.11 Genitalia

Unit II: (A) Insect Physiology

- 2.1 Alimentary canal : Structure and Physiology of digestion.
- 2.2 Tracheal system: Structure and Physiology of Respiration
- 2.3 Excretory system : Structure & types of Malpighian tubules, Physiology of Excretion and osmoregulation
- 2.4 Haemolymph : Composition and function

(B) Neuro-Endocrinology

- 2.5 Brain: Protocerebrum, Deutocerebrum & Tritocerebrum
- 2.6 Ventral nerve cord and ganglia
- 2.7 Neuro-endocrine glands: Types, structure & function
- 2.8 Neuro-haemal organs: corpora cardiaca and Aorta

Unit III: (A) Insect Control and Management

- 3.1 Chemical Control: Types (Chitin synthesis inhibitor, ecdysoids, juvenoids and anti-hormones) merits and demerits
- 3.2 Biological control: Types (parasites, parasitoids and predators) merits and demerits
- 3.3 Integrated Pest Management (IPM): Definition, tool, basic principle and importance

100/24/15
45/24/15
20/24/15

(B) Chemical nature and function

3.4 Pheromones

3.5 Diapause

3.6 Attractants, repellants and anti-feedants

Unit IV: Reproductions and Development

4.1 Male reproductive organs: Testes, Vas deferens, ejaculatory duct, accessory glands & seminal vesicles

4.2 Female reproductive organs: Ovaries, types of ovarioles, oviduct & common oviduct and accessory glands

4.3 Types of Larvae and their metamorphoses

Unit V(A) Agricultural Entomology

5.1 Pests of Paddy: Life history and control measures

5.2 Pests of Wheat: Life history and control measures

5.3 Pests of Sugarcane and stored grains: Life history and control measures

5.4 Pests of Vegetable and stored grains: Life history and control measures

(B) Veterinary Entomology

5.5 Bionomics, life cycle, prevention and control of house fly (*Fabonax* spp.) and Black fly (*Simulium* spp.)

5.6 Insect of medical importance associated with disease transmission (Malaria, Filaria and Kala-azar): Biology and control

(C) Forensic Entomology

5.7 Forensically important insects

5.8 Collection of data from cadaver site

5.9 Interpretation of data for predicting time and cause of death

SEMESTER - IV

EC - 2D Elective paper (Practical): Entomology

Time : 4 hrs

Full Marks - 70

CIA- 30

- | | | | |
|----|--|---------|----|
| 1. | Any one of the following experiments:
(i) Dissection of grasshopper or honey bee or wasp to expose general anatomy and nervous system
or
(ii) Identification of any two insects (5=2) | 10 | 05 |
| 2. | Permanent slide preparation of any one
(i) Whole specimen (small insect)
(ii) Mouth parts
(iii) Antennae
(iv) Legs
(v) Wings
(vi) Poison apparatus
(vii) External genitalia
(viii) Spiracles
(ix) Gills of aquatic insect | 10 | 05 |
| 3. | Identification and comments upon spots 1-5
(i) Morphological slides -2
(ii) Histological slides -2
(iii) Damaged material by a pest- 1 | 3x5= 15 | 05 |

2nd sitting

- | | | | |
|----|---|----|----|
| 4. | Identification and life history of any one pest | 10 | 05 |
| 5. | Field works and records | 05 | 05 |
| 6. | Dissertation & Viva voce | 20 | 05 |

Handwritten notes:
 100/200
 1/2
 1/2
 1/2

SEMESTER – IV

EC – 1C Elective paper : Environmental Biology

Time : 3 hrs

Full Marks – 70

Questions to be set in three parts representing all the five units. Part A will consist of 10 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five long questions (three to be answered) of 10 marks each.

Unit 1 : (A) Concept and dynamics of ecosystem

- 1.1 Biological productivity, primary production and method of its measurement
 - 1.2 structure and function of major ecosystem's of the world (fresh water ecosystems, forest ecosystems, grassland, desert ecosystem)
- (B) Limnology
- 1.3 Origin and types of lakes
 - 1.4 Ecological zonation in lakes

Unit 2 : (A) Population ecology

- 2.1 Concept of meta-population, demes and dispersal, interdemie extinctions, age structured populations.
 - 2.2 Stochastic and time lag models of population growth. Lotka-Volterra equation for competition and predation, functional and numerical responses.
- (B) Community ecology & succession

- 2.3 Nature of communities, community structure and attributes
- 2.4 Levels of species diversity and its measurements
- 2.5 Influence of population interaction on communities, types, mechanisms
- 2.6 Changes involved in succession, concept of climax

Unit III: (A) Biodiversity

- 3.1 Importance, status, monitoring, documentation, threats and conservation of biological diversity.
 - 3.2 Shannon-Weiner index, dominance index, Similarity index, Association index
- (B) Wildlife Management
- 3.3 Principles of conservation
 - 3.4 Major approaches to management, and Indian case studies on conservation/management strategy (project tiger, biosphere reserves)

Unit IV : (A) Pollution and environmental health

- 4.1 Global environmental problems, global warming, ozone depletion, acid rain, photochemical smog
 - 4.2 Sources, hazards and control of air, water and solid waste pollution
- (B) Ecotoxicology
- 4.3 Definition of toxicology
 - 4.4 Toxic substances in the environment
 - 4.5 Concept of dose response relationship

- 4.6 Acute toxicity, chronic toxicity, lethal concentration, effective concentration
- 4.7 Bioaccumulation, biomagnification, median tolerance limits.

Unit V (4) Environmental monitoring

- 5.1 Chemical and biological monitoring
- 5.2 Concept of indicator organisms and bio-monitoring of water quality
- 5.3 Concept of biotic and diversity indices.

- 5.4 Need and scope of bioremediation, environmental applications of bioremediation, future outlook
- 5.5 Phytoremediation- biotechnology of cleaning up the environment by plants

SEMESTER - IV

EC - 2C Elective paper (Practical): Environmental Biology

Time : 6 hrs

Full Marks - 70 CIA-30

Ist sitting

1. Qualitative and quantitative estimation of Zooplankton and Benthos	30	05
2. Studies of soil fauna by Quadrats method	05	05
3. Physico-chemical analysis of any one	10	05
(a) Water : DO, BOD, COD, Chloride, Carbonate and Bicarbonate alkalinity, Calcium and Magnesium hardness / Ca^{++} and Mg^{++}		
(b) Soil: pH, Chloride, Total alkalinity, Hardness, Water retention capacity of different types of soil.		
4. Estimation of Nitrite, Sulphate, and Phosphate by Spectrophotometry.	10	05

IInd sitting

5. Spotting - Zooplankton, Zoo-macro-benthos, Nekton (2x5)	30	05
7. Class Records	05	
8. Dissertation including Power Point Presentation and viva	20	05