

## Updated M.Sc. C.B.C.S. Syllabus (2020-21)

### Subject-Zoology

### Cooch Behar Panchanan Barma University

Sem	Paper code (Theo-T; Prac-P)	Paper Name	Theo (T)	CE	Attendance	Pract. (P)	Viva/Seminar	Total Marks
Sem 1	Core-101	Functional Biology of Nonchordates + Chordates	50	20	5	25		100
	Core-102	Biochemistry +Environmental Physiology	50	20	5	25		100
	Core-103	Ecology +Animal Behaviour	50	20 (Field Visit Report)	5	25		100
	Core-104	Developmental Biology + Endocrinology	50	20	5	25		100
Sem 2	Core-105	Genetics + Biotechnology	50	20	5	25		100
	Core-106	Cell Biology + Neurobiology	50	20	5		25 (Seminar & Manuscript submission)	100
	Core-107	Immunology + Viral & Microbial Pathology	50	20	5	25		100
	Core-108	Parasitology + Insect Biology	50	20	5	25		100
Sem 3	Core-109	Biodiversity & Wildlife + Aquaculture and Fisheries Resources of India	50	20	5		25 (Field Visit Report)	100
	DCE-1	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ <b>Stem Cell Biology &amp; Regenerative Medicine (Theory)</b> -anyone to be chosen	50	20	5		25 (Review/ Dissertation/ Training Prog. - Manuscript submission)	100
	DCE-2	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application /		20	5	50	25 (Seminar on Review/ Dissertation/ Training Prog.)	100

		Ecology/ Entomology / Fisheries/ Stem Cell Biology & Regenerative Medicine <b>(Practical)</b> / -anyone to be chosen						
	GE-1	Biophysics + Biostatistics/ (few will be added later on during syllabus upgradation)	50	20	5	25		100
Sem 4	Core-110	Evolutionary Biology +Population Genetics	50	20	5		25 (Group Discussion)	100
	DCE-3	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ Stem Cell Biology & Regenerative Medicine <b>(Theory)</b> anyone to be chosen	50	20	5		25 (Review/ Dissertation/ Training Prog. Manuscript submission)	100
	DCE-4	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ Stem Cell Biology & Regenerative Medicine <b>(Practical)</b> -anyone to be chosen		20	5	50	25 (Seminar on Review/ Dissertation/ Training Prog)	100
	GE-2	Taxonomy & Biosystematics + Bioinformatics ( few will be added later on during syllabus upgradation )	50	20	5		25 (Seminar)	100
								1600

## M.Sc. C.B.C.S. Syllabus (2020-21)

### Subject-Zoology

**SEMESTER 1**

**CORE- T-101**

**Theory:**

**Total Marks = 50**

**Functional Biology of Non-Chordates + Functional Biology of Chordates**

**Group A                      Functional Biology of Non-Chordates                      Full Marks: 25**

1. Animal Architecture: Body Symmetry, Body Size and Body Cavities
2. Locomotion:
  - a) Hydrostatic movement in Cnidaria, Annelida and Echinodermata
  - b) Significance of Segmentation with reference to locomotion
3. Respiration:
  - a) Physical factors, respiratory pigments in Non-chordates
  - b) Mechanism of respiration by gills, book lungs and tracheae
4. Nutrition and Digestion: Feeding pattern in lower metazoans
5. Excretion:
  - a) Excretory products, structures and mechanisms of excretion in Nonchordates
  - b) Osmoregulation in Non-chordates
6. Nervous System:
  - a) Primitive and advanced type of Nervous System
  - b) Trend of neural evolution in Non-chordates
7. Evolutionary Significance of non-chordate larval forms

**Group B                      Functional Biology of Chordates                      Full Marks: 25**

1. Biological Design:
  - a) Basic Vertebrate body plan and characteristics
  - b) Mechanics of body support and design: Size, Shape, Optics and Strength
2. Integument:
  - a) Phylogeny: Integument of Fishes, Integument of Tetrapods
3. Jaw Suspension: Fundamental and evolutionary significance, Cranial kinesis, Intracranial mobility in feeding mechanisms
4. Temporal region of the Reptiles and its evolutionary significance
5. Auditory system: Evolutionary changes and adaptive advantage
6. Evolution of cerebrum, functional association of CNS and information processing, role of cephalization in higher brain function
7. Sensory Organs: Chemoreceptors, Radiation Receptors, Mechanoreceptors and Electroreceptors

## CORE- T-102

**Theory:**

**Total Marks = 50**

### **Biochemistry + Environmental Physiology**

**Group A**

**Biochemistry**

**Full Marks: 25**

1. The nature of non-covalent interactions (van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.)
2. Bioenergetics: Internal energy, First Law of Thermodynamics, Enthalpy, Entropy, Second Law of Thermodynamics
3. Conformation of proteins - Ramachandran plot, secondary structure, domains, motifs and folds
4. Conformation of nucleic acids (A, B, Z), Reassociation kinetics and genome complexity, C-value paradox.
5. Stability of protein and nucleic acids
6. Lipids as signal cofactors and pigments.
7. Enzymes: Kinetics, Regulation, Mechanism of catalysis, Isozymes.
8. Glycolysis and its regulation, Citric acid cycle and its regulation, oxidation of fatty acids, oxidative phosphorylation, electron-transfer reaction in mitochondria.

**Group B**

**Environmental Physiology**

**Full Marks: 25**

1. Stress Physiology: Basic concepts of stress and strain, stress avoidance, stress tolerance, etc.
2. Basic concept and mechanism of Homeostasis
3. Respiration: Respiratory pigments: Oxygen dissociation curves: Transport of oxygen and carbon dioxide: Bohr effect, Root effect & Haldane effect; Physiology of diving birds and mammals.
4. Circulation of body fluids-Patterns of circulatory systems in animals: Kinds of blood vessels, Conductive tissue systems of heart in mammals: Cardiac cycle: Concepts of Electro Cardio Gram (ECG): Blood pressure: Concepts of haemodynamics.
5. Excretion and Osmoregulation:
  - a) Excretion-Concept of excretory organs in animals: Gross anatomy of kidney in mammals: Glomerular Filtration Rate: Tubular reabsorption and secretion.
  - b) Osmoregulation-Control of osmoregulation via ADH: Osmoregulation in aquatic and terrestrial animals.
6. Thermoregulation: Concepts of terminologies used (Endotherm, Ectotherm, Homeotherm, Poikilotherm, Heterotherm, etc); Concept of Temperature Coefficient (Q<sub>10</sub>); Adaptations to cold and heat by aquatic & terrestrial animals; Adaptive Hypothermia and Adaptive Hyperthermia; Thermal Neutral Zone; Thermogenesis, Evaporative cooling.

## CORE- T-103

### Theory

**Full Marks: 50**

### Ecology + Animal Behaviour

#### Group A

#### Ecology

**Full Marks: 25**

1. Community Ecology: Community Ecology-Biotic community concept, ecological dominance, Community analysis, species diversity, Competition and Coexistence, intra-specific and inter-specific interactions, scramble and contest competition models, mutualism and commensalism, prey-predator interaction
2. Population Ecology: Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, life table, fertility rate and age structure, dispersal, concept of metapopulation.
3. Human Ecology: Human population growth, resource use and sustainability
4. Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone depletion, acid rain, coping with climatic changes.
5. Pesticides and other chemical in agriculture, industry and hygiene and trends of their use.
6. Factors influencing bioaccumulation in food chain and during trophic transfer. Impact of chemical pollutants on biodiversity of microbes, animals and plants.
7. Bioindicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.

#### Group B

#### Animal Behaviour

**Full Marks:25**

1. **Ethology:** Definition, Scope, Importance, Basic concepts and models of classical ethology. Questions about animal behaviour, The escaping cockroach, The courtship of the sage grouse, Units of the nervous system, Reflexes and more complex behaviour, Diversity and unity in the study of behaviour
2. **The Development of Behaviour :** Young animals grow up, Instinct and learning in their biological setting, The characteristics of instinct and learning, Genetics and behaviour, Development and changes to the nervous system, Hormones and early development, Early experience and the diversity of parental behaviour, Play, Imprinting, Bird song development
3. **Stimuli and communication:** What stimuli are and how they act, Diverse sensory capacities, The problem of pattern recognition, Sign stimuli (key features), 'Supernormal' stimuli, Neuroethological basis of sign stimuli, Other solutions for pattern recognition: generalized feature detection, **Communication**, What is communication? Animal signals as effective stimuli - aggression, predation, song,

complex communication, Honesty and deception in animal signalling , The honeybee dance, The calls of vervet monkeys

4. **Foraging:** Optimal foraging theory; learning and foraging; molecular, neurobiological and hormonal aspects of honey bee foraging
5. **Decision-making and motivation:** Decision-making on different time scales, Decision-making and ‘motivation’, Measuring motivation, Is motivation specific or general, Goals as decision points, Homeostasis and negative feedback, Competition between motivations, Inhibition/disinhibition, Decision-making with incomplete information: the role of signals, Conflict and ‘abnormal’ behavior, The physiology of decision-making, Hormones and sequences of behavior, Conflict and physiological stress, Decision-making, motivation and animal welfare.
6. **Learning and memory:** Learning as part of adaptation, Sensitization and habituation, Associative learning, Specialized types of learning ability, What do animals actually learn? Are there higher forms of learning in animals?, The comparative study of learning, Social learning and culture, The nature of animal minds, The nature of memory
7. **Evolution:** The adaptiveness of behavior, Genes and behavioural evolution, Kin selection and inclusive fitness, Prisoner’s dilemma, selfish gene theory and green beard hypothesis, Evolutionarily stable strategies, Sex and sexual selection, Species isolation and species selection, Tinbergen’s fourth question: the phylogeny of behaviour
8. **Social organization:** The individual in the crowd, Advantages of grouping, Diverse social groups Eusociality: division into castes, Territory in the social organization of vertebrates, Courtship and Mating systems and social organization, Dominance in social systems, Diverse mammalian social behavior, Nidification in birds, Primate social organization
9. **Wildlife behavior:** Aggression, agonistic behavior, competition, territory, dominance, movements and conflict.

## CORE-T-104

**Theory**

**Full Marks: 50**

**Developmental Biology & Gamete Biology + Endocrinology**

**Developmental Biology & Gamete Biology Full Marks: 25**

## Group A

1. Fundamentals of development: Potency, commitment, specification and its types, determination, morphogenetic gradient and French-flag model, fate map, induction and its types, cell-cell communications during development, cell death mechanisms and its importance in development, concept of genomic equivalence.
2. Gametogenesis, fertilization and early development: Spermatogenesis, oogenesis, structure of sperm and ovum, external and internal fertilization, morulation, blastulation

in frog and chick, placentation and types of placenta in mammals, concept of gastrulation, morphogenetic movements and fate map, extra-embryonic membranes.

3. Morphogenesis and organogenesis in animal models: Vulva formation in *C. elegans*, Axis patterning and development pattern in *Drosophila*, brain and eye formation in tetrapods, limb formation in tetrapods, kidney formation in tetrapods, axis patterning and organizer concepts in amphibians.
4. Regeneration, metamorphosis and senescence: Examples and events of epimorphic, morphalactic, compensatory regeneration, stem cells and its use in regenerative medicine; metamorphosis in insects, *Ascidia*, toad, different types of heterochrony in salamanders; aging and senescence, theories and molecular events of senescence.
5. Developmentally important signaling cascades: Wnt, Hh, Notch, SMAD, RTK signaling cascades.
6. Stem Cell Science: Stem cell types, sources, stem cell niche concept, different stem cell based therapeutic strategies, concept of iPSC, ethical concerns regarding stem cell research.
7. IVF: Concept of ART and IVF, procedure of IVF and embryo transfer, concept of surrogacy.

### **Group B**

### **Endocrinology**

**Full Marks: 25**

1. Classification of hormones based on chemical composition and molecular action.
2. Pituitary gland: Hormones and regulations
3. Thyroid gland: Hormones and functions.
4. Parathyroid hormone and other regulators of Calcium and Phosphorous metabolism.
5. Adrenal gland: Cortical and medullary hormones and their functions.
6. Endocrine pancreas: Hormones and their functions.
7. GI tract hormones: Diversity, cellular origin and functions of different GI-tract hormones.
8. Hypothalamus, Pineal and Thymus glands- structures and functions.
9. Hormones and reproduction: Male and female hormones and their functions.
10. Biosynthesis: Steroid hormones and some protein hormones.
11. Diseases related to hormonal deficiency/overproduction.
12. Molecular mechanism of hormone actions.

## **LABORATORY COURSES**

**CORE P 101****Full Marks:25****Practical: Non-Chordate and Chordate**

1. Mounting of: *Paramecium*, *Nyctotherus*, *Amoeba*, *Opalina*, Soil Nematodes, Gut nematode of fish and toad, *Cyclops*, *Daphnia*.
2. Submit a project report to study the diversity of Protista of pond water collected from different places.
3. Identification of Larva: Ephyra, Nauplius, Zoea, Mysis, Megalopa, Glochidium, Trocophore, Veliger, Bipinnaria. Location and extraction of pituitary gland of carp
4. Find position of accessory air-breathing organs of *Anabas* sp. / *Clarias* sp. / *Heteropneustes* sp.
5. Gallus/Columba: 5<sup>th</sup> and 7<sup>th</sup> Cranial nerves
6. *Rattus* sp. / *Mus* sp.: Nerves of the neck region

**CORE P 102****Full Marks:25****Practical: Biochemistry & Environmental Physiology**

1. Quantitation of DNA by UV-vis spectrophotometer
2. Electrophoretic separation of DNA
3. Protein estimation by Folin Lowry method.
4. Comparison of Total RBC and WBC counts in different groups of vertebrates
5. Estimation of Haemoglobin and Differential count of blood in vertebrates
6. Study of the changes of blood glucose level in a vertebrate species

**CORE P 103****Full Marks: 25****Practical: Ecology & Behaviour**

1. Water Analysis: Estimation of dissolved oxygen, free carbon dioxide; total alkalinity; total hardness and chloride
2. Soil Analysis- Estimation of percentage of calcium carbonate by rapid titration method. Estimation of organic-carbon by wet oxidation method
3. Estimation of primary productivity of aquatic ecosystems using light and dark bottle method.
4. Field Study for Assessment of density, frequency and abundance of plants/animal in a forest area, hill or sea shore using various techniques i.e. transect, quadrat etc.
5. Study the aggressive behavior of Fish (*Channa* sp. / *Betta* sp.)



**Practical: Developmental Biology and Gamete Biology + Endocrinology**

1. After incubating the eggs for different days, take out the embryo and dissect out different organs, dissociate them and observe their characteristics and behavior, fix the cells.
2. Stages of development upto three layer formation in different vertebrate classes (Desirable: Study in class with fresh fish/ frog embryo)
3. Developing organs of chick in histological sections
4. Identification of regeneration stages in histological preparation (*Hydra* sp. / limb of amphibia)
5. Study of life cycle of *Drosophila melanogaster*.
6. Surgical techniques such as adrenalectomy, thyroidectomy, castration, etc. to be done on rats or mice.
7. *In situ* studies of endocrine organs in mammals
8. Basic techniques of histology - Tissue fixation, embedding, block preparation, sectioning, stretching and differential staining (Haematoxylin- Eosin)
9. Histological studies of gonads and endocrine glands in mouse/rat

**SEMESTER-II****CORE- T 105****Theory****Full Marks = 50****Genetics + Biotechnology****Genetics****Full Marks = 25****Group A**

1. Mendelian principles and its extensions, epistasis, penetrance and expressivity and genetic maternal effect. Pedigree analysis.
2. Microbial genetics: Transformation, Conjugation, Sexduction, Transduction and mapping genes by interrupted mating
3. DNA Replication and Repair Systems: Enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanism
4. RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, RNA polymerase, capping, elongation and termination, RNA splicing and polyadenylation.

5. Protein Synthesis: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, translational inhibitors, Post-translational modifications of proteins
6. Recombination: Concept of homologous recombination, Site specific recombination, FLR-FRT system, Cre-lox system
7. Gene Regulation: Lac Operon, Trp Operon, Lytic and Lysogeny in Bacteriophage, Methylation and Eukaryotic gene regulation.

**Group B**

**Biotechnology**

**Full Marks = 25**

1. Recombinant DNA technology: Restriction Endonucleases, Vectors, Cloning strategies, selection of recombinant DNA, DNA sequencing, PCR, Next generation sequencing, Shotgun sequencing of whole genome, cDNA libraries: construction and screening. Plasmid mapping, Transposons
2. Expression vectors and expression of fusion proteins
3. Transgenic Animals: production, prospects, advantages and disadvantages
4. Site directed mutagenesis: strategies and prospects
5. Applications of recombinant DNA technology in human gene therapy, vaccine development, environmental bioremediation and protein engineering
6. Microbial synthesis of commercial products: restriction endonucleases, antibiotics, vitamins, amino acids and dyes

**CORE T 106**

**Theory**

**Full Marks = 50**

**Cell Biology + Neurobiology**

**Group A**

**Cell Biology**

**Full Marks = 25**

1. The Cell Nucleus: Chromosomal DNA and its packing
2. Biomembrane Structure: Lipid composition and structural organization, Membrane proteins, Membrane Fluidity
3. Transmembrane Transport: Carrier proteins and active membrane transport (uniport, symport and antiport), membrane pumps, gated ion channels
4. Biomolecule Trafficking: Role of endoplasmic reticulum, Golgi bodies, mitochondria and molecular chaperons in trafficking; function of cytoskeleton and its role in motility.
5. Cell Signalling: G-protein coupled receptor mediated, enzyme linked cell surface receptor mediated signalling and second messengers
6. Cell cycle and its regulation
7. Apoptosis: Receptor-mediated and mitochondria mediated apoptotic pathways

**Group B**

**Neurobiology**

**Full Marks = 25**

1. Organization of Nervous System: Origin and Differentiation of Neurons.
2. Electrical potentials Neurilemma and their molecular basis.
3. Propagation of Nerve impulse along Neuritis and their molecular basis.
4. Synapse: Synaptic transmission and Neuromodulation.
5. Integration of synaptic functions: Synaptic plasticity.
6. Neurotransmitters: Classification, synthesis, release and functions, inactivation of Neurotransmitters.
7. Brain motor mechanism: Sensory motor integration.
8. Nature of Somatic motor actions in reference to muscles.
9. Organization and functions of autonomic nervous system: Hypothalamus
10. Neuro-endocrine integration: Components, orders and feedback regulation.
11. Neural basis of learning and memory.

**CORE T 107**

**Theory**

**Full Marks = 50**

**Immunology + Viral & Microbial Pathology**

**Group A**

**Immunology**

**Full Marks = 25**

1. Hematopoiesis: Progenitor cells, Hematopoietic growth factors, programmed cell death (apoptosis), clinical uses of hematopoietic stem cells.
2. Innate Immunity: Phagocytosis (Oxygen dependent and Oxygen-independent), Inflammation (Mediators & Cytokines), Complement system (Classical, Alternative and Mannan-Binding Lectin Pathway)
3. Adaptive Immunity: Antibody-mediated immunity, Cell-mediated immunity
4. Transplantation Immunology: Major Histocompatibility Complex (Types & functions)
5. Antigen Presentation: Intracellular and Extracellular Pathway
6. Concept of Tolerance; mechanism of breakdown of tolerance leading to Autoimmunity.
7. Hypersensitivity: Types and its related diseases
8. Immunoassays for disease detection: Antibody Titre, Immunofluorescence, Radioimmunoassay, ELISA, Rapid Tests, Immunoelectrophoresis, Immunoblots etc.

**Group B Viral & Microbial Pathology**

**Full marks = 25**

1. Viral Pathogenesis: Sites of viral entry (Respiratory, Alimentary and Urogenital tract), Genetic determinants of Virulence, Cytopathic effect
2. Antiviral drugs: Mode of Action (Amantidine, Nevirapine, Acyclovir, Azidothymidine, Remdesivir, Indinavir), Repurposing of drugs for antiviral treatment (e.g. SARS CoV-2)
3. Bacterial pathogenesis: Virulence & Attenuation, Exotoxins (Cytotoxins, Diphtheria Toxin, Tetanus Toxin, Cholera Toxin), Endotoxins (LPS), Pathogenicity Islands, Quorum Sensing
4. Antibacterial drugs: Targets of antimicrobial agents, Mode of action (Sulfonamides, Quinolones, Penicillins, Cephalosporins, Tetracyclines, Rifampin), Antimicrobial Drug Resistance (Mechanism and Transmission of Resistance)
5. Antimicrobial Drug susceptibility testing: Minimum Inhibitory Concentration (MIC), Antibiotic Sensitivity Testing

6. Brief idea about Healthcare Associated Infections (HAI)

**CORE- T 108**

**Theory**

**Total Marks = 50 marks**

**Parasitology + Insect Biology**

**Group A**

**Parasitology**

**Full Marks = 25**

1. Classification, Geographical distribution, Morphology, Life-cycle, Transmission, Pathogenicity, Treatment and Prophylaxis of:
  - a. Protozoan parasites: *Entamoeba* spp, *Trypanosoma* spp., *Leishmania* spp. (any one)
  - b. Intestinal flagellates *Giardia* spp.
  - c. Cestodes: *Taenia* spp.
2. Clinical and veterinary parasitology - detection, diagnosis, prophylaxis, treatment, and pharmacology (emergent parasites).
3. Host parasite interaction- immunological nuances in vertebrates and invertebrates and epidemiological surveillance tools. Manipulation of host behaviour, parasitism & altruism, parasites & social behaviour of hosts.
4. Immune evasion strategies of parasitic protozoa and helminthes.
5. Epidemiology of parasitic diseases-general epidemiology, methods of epidemiological study, epidemiology of Malaria, Leishmaniasis, and Amoebiasis.
6. Community medicine.
7. Vector biology with special reference to Malaria and Kala-azar.
8. Genome organization in *Plasmodium* sp., molecular basis of antigenic variation in *Plasmodium* sp.

**Insect Biology Full marks = 25**

**Group B**

1. Insect Classification- Major order with characters and examples
2. Trophic adaptations in insects
3. Reproductive strategies in insects
4. Insect development, metamorphosis and life cycle patterns
5. Concept of pest status and classification of pesticides
6. Introduction to major vectors, pest of medical and agricultural importance from India
7. Remote sensing techniques in assessing Crop damage and protection
8. Methods of insect pest control: Conventional and non-conventional  
Concept of integrated pest management.

## LABORATORY COURSES

### CORE P 105

**Full Marks: 25**

#### **Practical: Genetics+ Biotechnology**

1. Study of common mutants in *Drosophila* spp.
2. Pedigree analysis of common human dominant/recessive traits (PTC, rolling tongue polydactyly, Red-Green colour blindness etc.)
3. Detection of ABO blood groups and determination of gene frequencies in human population.
4. Bacterial culture: Agar plate, liquid broth
5. Genomic DNA/Plasmid isolation (Demonstration)
6. Electrophoretic analyses of uncut and linearized plasmids

### CORE P 106

**Full Marks : 25**

#### **Practical (Seminar) Cell Biology + Neurobiology**

- |                          |          |
|--------------------------|----------|
| 1. PPT Presentation      | 15marks  |
| 2. Manuscript submission | 10 marks |

### CORE-7 P

**Full Marks: 25**

#### **Practical: Immunology + Viral & Microbial Pathology**

1. Collection of Plasma and Serum
2. Dissection of primary and secondary immune organs from mice
3. Preparation of single cell suspension from spleen of mice/rat and cell counting
4. Trypan blue dye exclusion test
5. Basic idea about bacterial culture media and culture methods
6. Gram staining

### CORE-P 108

**Full Marks: 25**

#### **Practical: Parasitology + Insect Biology**

1. Staining of blood films for parasitic protozoa / microfilaria and gut content of arthropoda / amphibian, with proper illustrations.
2. Whole mount preparation of trematode and arthropod parasites.
3. Staining of scolex and proglottids of cestodes.
4. Collection, preservation, staining, mounting and identification of ectoparasites or endoparasites of wild rat / cattle / dog / chick / human.
5. Preparation- Mouth parts and salivary glands of cockroach, Mouth parts of mosquito
6. Isolation of haemolymph

## **SEMESTER III**

**CORE T 109**

**Theory`**

**Full Marks = 50**

**Biodiversity & Wildlife + Aquaculture and Fisheries Resources of India**

**Group A**

**Biodiversity & Wildlife**

**Full Marks = 25**

1. Definition and indices of biodiversity
2. Levels of biodiversity: genetic, species and ecosystem
3. Biodiversity act and related International conventions
4. Threats to biodiversity, sustainable development, natural resource management in changing environment
5. Classification of wildlife according to severity of threats, CITES
6. Conservation: Rationale for wildlife conservation, models of wildlife management and conservation, *in situ* and *ex situ* conservation, Socio-economic perspective of wildlife conservation.
7. Wildlife laws and bodies: Wildlife Protection Act, National Biodiversity Authority and National Tiger Conservation Authority (NTCA)
8. Tiger Census: Methods, Trend and Criticism
9. Joint forest management: Arabari Model

**Group B Aquaculture and Fisheries Resources of India**

**Full Marks = 25**

1. Aquaculture: Definition, scope and importance; Aquaplosion; Aquaranching
2. Concepts of different systems of freshwater aquaculture and their management
3. Basic cultural aspects of Ornamental fishes, Air-breathing fishes, Freshwater prawns and their prospects and problems.

4. Hypophysation technique, Synthetic Hormones (Ovaprim, WOVA-FH, etc.), Chemical structure, Role and Utility in induced breeding, Inbreeding Depression.
5. Hybridization in Fishes; Basic concepts of Selective Breeding in Fishes; Androgenesis, Gynogenesis, Polyploidy- their role and utility in Aquaculture; Sex-reversal in Fishes. Fish as resource for genetic research (Zebra fish).
6. Common Diseases in Edible and Ornamental Fishes: Viral, bacterial, fungal, protozoan, helminthes and crustaceans- their symptoms and control remedies.
7. Coldwater/Hill-stream fishery: Characteristics of Coldwater/Hill-stream bodies, major genera of coldwater/Hill-stream fishes with examples from North Bengal.
8. Mariculture- Definition and Scope; Basic ideas on Molluscan (Pearls and Edible Oysters).
9. Basic concepts on the Fisheries Resources of India: Estuaries, Reservoirs. Backwaters, Brackish-waters and Lakes

### **Discipline Centric Electives (DCE)- Specialization/Major**

**NOTE: Following DCE are offered by the respective Faculty members of Dept. of Zoology, CBPBU:**

- **Molecular Immunobiology and Immunogenetics (DCE-A) –Offered by Dr. H Yasmin**
- **Molecular Cell Biology and Oncology (DCE - C) - Offered by Dr. Samik Bindu**
- **Parasitology and Epidemiology with Artificial Intelligence Application (DCE- D)- Offered by Prof. Pradip K Kar**
- **Stem Cell Biology and Regenerative Medicine (DCE-H)- Offered by Dr. Ritam Chatterjee**

**Thus, the above mentioned DCE will only be availed by the students enrolled at CBPBU and not in any other Study Centres/ Colleges under CBPBU**

**DCE 1- T**

**THEORY**

**Molecular Immunobiology and Immunogenetics (DCE1-A)**

**Theory**

**Full Marks: 50**

1. Cell migration and inflammatory response: cell surface adhesion molecules, leukocyte migration, inflammasome
2. Immunity to Infectious Agents: Immunity to Intracellular and extracellular bacteria, (PAMPs, DAMs, PPRs (TLRs, NLRs, RLRs) Autophagy, Pyroptosis, etc);
3. Immunobiology of Infectious diseases:
  - Tuberculosis/Leprosy (Antigenic virulence, M1 and M2 polarization, Granuloma formation, HLA gene and disease susceptibility)

- Malaria/ Leishmaniasis- Life cycle and Immunopathogenesis
  - HIV-1(Genomic characteristics, binding and entry into target cells and mucosal immunity, other associated diseases)
  - SARS-CoV-2 (Genomic characteristics, binding and entry into target cells, lung inflammation, cytokine storm and other comorbidities)
4. Modern vaccine trails against Tuberculosis, Malaria, Leishmania, HIV-1 and SARS CoV-2
  5. CRISPR Technology its applications and bioethics
  6. Mouse as a model for human disease study (Knockout, Transgenic, SCID); Animal ethics
  7. Hybridoma Technology (Monoclonal antibody production): Use of Gene Libraries to derive monoclonal antibodies (mAb), Humanized mAb and clinical applications
  8. Immune ageing: mechanism and therapeutic targets

### **Molecular Cytology and Genetics (DCE1-B)**

#### **Theory**

**Full Marks: 50**

1. Cell/Tissue culture techniques:
  - i) Culture media, Properties and preparation,
  - ii) Primary Cell culture, Cell lines, Lymphocyte / Fibroblast culture
  - iii) Cell separation by FACS
2. Cell-cell signalling: Cell surface receptors, G-protein coupled receptors, Signal amplification
3. Mitochondrial DNA: Organization, replication and diseases
4. Prion: replication, TSE and PrPc
5. Stem Cell: Biology and its application, asymmetric cell division and its regulation
6. Biology of aging and its genetic control
7. Gene Function analysis: Random mutagenesis, Site specific mutagenesis, targeted mutagenesis: gene knockout and knock-in method, Gene silencing and genome editing.
8. Molecular Virology:
  - i) Biology and strategy of DNA and RNA animal viruses.
  - ii) Gene expression and Regulation of SV 40, HBV and HIV
9. Patterns of inheritance: Family studies, Mendelian inheritance, Multiple alleles and complex traits, Anticipation, Uniparental disomy, Genomic imprinting, Multifactorial Inheritance-Polygenic theory.

### **Molecular Cell Biology and Oncology DCE 1C**

#### **Theory**

**Full Marks: 50**



1. Interorganellar crosstalk, protein sorting and vesicular trafficking: Anterograde vs retrograde signalling. Macromolecular transport / crosstalk between subcellular compartments.
2. Intercellular crosstalk and relay of messages: Role of gaseous compounds and calcium in signal transduction. Danger associated molecular patterns and relay of signals. Mitochondrial DAMPs in cellular pathology.
3. Cellular stress, quality control and homeostasis: Oxidative stress, mitochondrial oxidative stress, ER stress, unfolded protein response, ERAD. Autophagy, Mitochondrial dynamics, mitophagy and bioenergetic crisis.
4. Stem Cell Biology: Concept of potency, self-renewal. Dedifferentiation and transdifferentiation. Concept of niche, stem cell isolation and marker-based characterization. Stem cells and regenerative medicine
5. Techniques in Molecular Cell Biology: Cell culture techniques, media preparation, sterilization and fumigation. Primary cell, cell line, stable cell line. Transfection of cells. Analysis of mitochondrial transmembrane potential, cellular oxidative stress, cell cycle and cell death by flowcytometry.

### **Parasitology and Epidemiology with Artificial Intelligence Application (DCE1 D)**

#### **Theory**

**Full marks: 50**

1. Parasites and parasitism : General consideration, Type of parasites, Type of hosts, Symbiosis and Commensalisms
2. Molecular interaction between host and parasite and evasion of immunity
3. Protozoan parasites, Distribution, habit and habitat, structure, life cycle and diseases caused by *Entamoeba histolytica*, *Leishmania donovani*
4. Epidemiology of diseases of public health importance and disease control
  1. Epidemiological aspects of diseases of national importance: Malaria, Filariasis, Leishmaniasis
  2. Infectious disease Epidemiology.
5. Biological Sequence Analysis in Parasitology: Analysis of DNA and Protein sequence, Sequence alignment, Fragment assembly, Genome sequence assembly, Neural network concepts and secondary structure prediction, Probabilistic models, Evolutionary analysis

### **Ecology (DCE1-E)**

#### **Theory**

**Full Marks:50**

1. Principles pertaining to limiting factors: Leibig's law of the minimum, Shelford's Law of tolerance, Law of limiting factors, Factor compensation and ecotypes, Combined concept of limiting factors.
2. Concept of habitat and Niche: Habitat and microhabitat, Development of Niche concept, Niche width, Niche overlap, Diffuse competition, Niche dynamics, Niche- a

- property of the species or the community, Ecological equivalents, Character displacement Sympatry, Allopatry.
3. Soil: Composition, Soil profile, Soil formation, Soil classification and distribution
  4. Radiation ecology: Types of ionizing radiations, Radionuclides of ecological importance, Comparative radio sensitivity, Fate of radionuclides in the environment, Fallout problems, Waste disposal.
  5. Biological rhythms: Periodicity in the environment and in the organisms, Circadian rhythm-Selective advantage, Free-running activity, Temperature compensation, Ontogeny and ageing effect, Genetic control.
  6. Ecosystem development: The strategy of ecosystem development, Concept of climax, Theories, Coevolution
  7. Human ecology: Ecological back ground of human origin, Disruptive and directional selection, Brain evolution, Social innovation, Population ecology of man.
  8. Wildlife: Values of wildlife, Principle of wildlife management, Wildlife conservation, Data base of wildlife management, Cloning and wildlife conservation.
  9. El-nino, La-nina, Southern Oscillation and their ecological impact.
  10. Relation between and within species.

### **Entomology (Insect Physiology and Industrial Entomology)-(DCE1 F)**

#### **Theory**

**Full Marks: 50**

1. Insect hormones: Sources, biosynthesis, transport, mode of action and regulation of their titers
2. Haemolymph, haemocytes and Insect Immunity
3. Intra-specific and inter-specific chemical and mechanical communications in insects
4. Insect flight mechanism and migration
5. Genetics of mulberry silk moth in reference to voltinism, moultinism and economic characters. Breeding strategies in Mulberry silkworms and management of its diseases and enemies.
6. Influence of environment on insect development and life cycle traits: The Degree-Day concept.
7. Mechanisms of change in insecticide susceptibility and resistance management techniques
8. Honey bee: Role in pollination and production of honey, propolis and bee-wax; extraction and preservation of honey
9. Termites: Eusocial organization, role as builders, reducers and depredators
10. Insect based drugs, dyes, food and aesthetics

### **Fisheries (Applied Ichthyology and Aquaculture) (DCE1 G)**

**Theory****Full marks:50**

1. Fish Growth: Measurement of growth, patterns of growth (allometric, isometric, relative, absolute); Length-weight relationship; Condition factor or K-factor or Ponderal Index.
2. Fish Age: Methods of age determination: Length- Frequency method (Peterson Method)
3. Knowledge of Maturity, Fecundity and Gonado Somatic Index.
4. Fish Migration: Types and Effects of Dams on Fish Migration.
5. Fish Toxicants used in Aquaculture.
6. Fish Seed Production and Collection from nature; Different kinds of Hatcheries (Hatching hapa, Glass Jar, Chinese Hatchery, LDPE hatchery)
7. Selective Breeding: Genome Manipulation; Sex-reversal; Transgenic fish; Cryopreservation.
8. Organic farming: Organic Manures and Inorganic fertilizers used in Pond fertilization
9. Composite/Polyculture/Mixed Fish Farming – Principles, Management practices, intermediate harvesting.
10. Fish Nutrition – Supplementary feeding; Different kinds of Processed feeds; Feed ingredients & Feed formulation; Micro-encapsulated diet; FCR and FCE; Dry & Moist feed; Medicated feed; Food energy.
11. Sewage Fed Fisheries
12. Soil and Water quality criteria for pond fish culture.

**Stem Cell Biology and Regenerative Medicine (DCE1 H)****Theory****Full marks:50**

1. Origin of stem cells: Early embryonic development and Origin of stem cells from early embryo, Formation of germ layers and placenta, amnion and amniotic membrane, yolk sac and allantois, Development of Primordial germ cells (PGCs) and embryonic germ (EG) cells, Difference between Embryonic stem (ES) cells and Embryonic germ cells (depending upon their developmental stage) and their generation capacity of different lineages, Ontogeny of Adult stem cells and their specific lineage relationships.
2. Functional characteristics of stem cells: “Stemness” of stem cells – Definition, self-renewal and differentiation; Potency and clonality of stem cells; Explaining De-differentiation and Trans-differentiation of stem cells; Signaling cascades for the regulation of Stemness.
3. Types of stem cells –
  - Embryonic stem (ES) cells – location, morphology, properties, markers of ES cells; embryoid bodies; clinical potentials of ES cells and utilization in therapy; research on ES cells and controversies; ES like cells in different species.
  - Hematopoietic stem cells (HSCs) – Properties, markers, ontogeny of HSCs; Proliferation and differentiation of HSCs; hematopoiesis supportive growth

factors; different hematopoietic colony forming units (CFUs); transplantational use of HSCs.

- Peripheral blood stem cells and endothelial cells – Types of stem cells in peripheral blood; Therapeutic potential of peripheral blood stem cells and endothelial cells (focusing along with their expression markers)
  - Mesenchymal stem cells (MSCs) – Morphology, location, markers, properties of MSCs; Multilineage differentiation potentials of MSCs; MSC as trophic mediators; clinical applications of MSC in cell therapy.
  - Neural stem cells (NSCs) – NSCs and neurogenesis.
  - Induced pluripotent stem cells (iPSCs) – Development of iPSCs and re-programming factors; therapeutic importance of iPSCs
4. Stem cell niche – Stem cell niche hypothesis, components of stem cell niche, role of stem cell niche, germ line stem cell niche, adult stem cell niches in mammals, signaling in stem cell niche, dysregulation of stem cell niches, *Ex-vivo* generation of stem cell niches.
  5. Concept of cancer stem cell (CSC) and CSC niche – Defining stemness in cancer, theories of origin of CSCs, difference between CSCs and normal stem cells, markers of CSCs in different types of malignancy, functional properties of CSCs, different components of CSC niche, CSC and CSC niche targeted anti-cancer therapeutic strategies.
  6. Isolation and culture of stem cells – Dye efflux method of stem cell isolation, magnetic and flowcytometric method of isolation of stem cells, density gradient centrifugation in stem cell isolation, basic idea of cell culture, culture of ESC, MSC, HSC, CFU culture from bone marrow derived cells.

## **Generic Elective (GE)**

### **GE-1 T**

### **THEORY**

#### **Biophysics + Biostatistics**

**Full Marks = 50**

#### **Group A**

#### **Biophysics**

**Full Marks = 25**

1. Assay: Definition, criteria of reliability.
2. Principles and uses of analytical instruments: Spectrophotometer, Spectrofluorometer, Mass Spectrometry
3. Microscopy: Fluorescence and Confocal Microscopy, Electron Microscopy (SEM and TEM)
4. Chromatography: Principles, Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, Gel exclusion chromatography, Affinity chromatography
5. Electrophoresis: Basic principles, PAGE, Agarose gel electrophoresis, 2-D gel electrophoresis, Basic concept on Western, Southern and Northern Blotting

6. Centrifugation: Basic principles of Sedimentation, Differential and Density gradient centrifugation.
7. Crystallography and X-ray diffraction, Basic idea of NMR.
8. Radioisotope techniques: Radioactivity and half life, radioisotopes, units of radioactivity, G-M Counter, solid and liquid scintillation counter, Metabolic labelling, Applications of radioisotopes.

### **Group B**

### **Biostatistics**

**Full Marks = 25**

1. Biostatistics/Biometry: Definition and utilization in biological assays.
2. Basic Concepts of:
  - a) Terminologies used in biostatistics: Variable, Population, Data, Sample estimate.
  - b) Measures of Central Tendency
  - c) Measures of Variation
  - d) Graphical representation of data.
3. Hypothesis Testing and Student's T-test distribution.
4. Probability Distribution-Concept Probability, Binomial Distribution and Poisson Distribution
5. Simple Linear Regression and Correlation
6. Chi-Square Test.
7. Analysis of Variance.
8. Models: Definition, Classification, Usefulness.

## **LABORATORY COURSES**

### **CORE P 109**

**Full Marks = 25**

#### **Biodiversity & Wildlife + Aquaculture and Fisheries Resources of India**

1. Submit a report on the biodiversity study undertaken in your campus/locality/forest/river bed/sea shore 15 marks
2. Viva voce 10 marks

### **DCE -2P**

#### **Molecular Immunobiology and Immunogenetics (DCE2-A)**

#### **Practical**

**Full Marks: 25**

1. Learning basic cell culture techniques: Maintaining Cell Lines (Primary, secondary)  
Understanding Cellular morphology through microscopy
2. Mouse handling and studying different routes of drug administration in mouse model (oral, topical, *iv*, *ip*, *sc*, *in situ*)
3. Raising polyclonal antibody in mice against sheep RBC, serum collection and estimating antibody titre in serum
4. Differentiate the primary and secondary antibody response in haemagglutination test by using mercaptoethanol.
5. Separation of human lymphocytes in Hypaque Ficoll gradient

## **Molecular Cytology and Genetics (DCE2-B)**

### **Practical**

**Full Marks: 25**

1. Preparation of mitotic chromosomes from the bone marrow of Mice by Air dry/Flame dry method
2. Preparation of meiotic chromosome from the testes of Mice by Air/Flame dry method.
3. Preparation of Synaptonemal Complex by surface spread method from the testes of mice
4. *Drosophila* food preparation, handling of flies and Setting up of crosses
5. Study of life cycle of *Drosophila melanogaster*
6. Study of *Drosophila* mutant phenotypes.
7. Three-point test cross from gene mapping in *Drosophila*.
8. Construction of Karyotype of Human/Rat.

## **Molecular Cell Biology and Oncology (DCE2-C)**

### **Practical**

**Full Marks: 25**

1. Nucleic acid isolation, quantitation, agarose gel electrophoresis and visualization.
2. Designing of primers (*in silico*) and Nucleotide BLAST.
3. PCR demonstration.
4. Restriction digestion of Plasmid/Genomic DNA and electrophoresis. Plasmid mapping.

## **Parasitology and Epidemiology with Artificial Intelligence Application (DCE2-D)**

### **Practical**

**Full Marks: 25**

1. Smear preparation for protozoa
2. Preparation of whole mounts for helminthes
3. Collection of parasites: Protozoans/ Nematodes/ Helminthes/ Insects.
4. Examination of different living animal hosts (domestic and wild) for collection, preservation, mounting and identification of protozoan parasites and arthropod vectors. Preparation and study of protozoan culture. Study of permanent slides of protozoan parasites and arthropod vectors; Microscopical examination of blood smears for protozoan parasites and isolation and identification of protozoan cysts and eggs of Helminth parasites from fecal samples. Use of Ocular micrometer and Stage micrometer for measurement.
5. Examination of living animal hosts (definitive and intermediate: earthworm, cockroach, bony fish, toad, wall lizard, garden lizard, pigeon, fowl, rat etc.) for collection, preservation, and identification of different helminth parasites. Identification of helminth parasites of man. Studies of different sections (transverse, longitudinal, sagittal) of parasites by using microtomy method and Histopathological studies of different types of infected tissues of the host. Preparation of Helminth Culture. Extraction and slide preparation of nematodes from different habitats including the isolation of the entomopathogenic nematodes and sampling and estimation of

- population of nematodes from soil and plant tissues. Microphotography of parasites. Identification of photos of different stages of parasites and diseases.
6. Preservation and Identification of parasites: Protozoans, Nematodes, Helminthes, Insects

### **Ecology and Animal Behaviour (DCE2-E)**

#### **Practical**

**Full marks 25**

1. Study of primary productivity of a pond using light and dark bottles
2. Physico-chemical analysis of pond water
3. Succession of bacterial population in milk
4. Population studies of *Tribolium* sp.
5. Learning experiment with white mouse in T-maze

### **Entomology (DCE2-F)**

#### **Practical**

**Full marks 25**

1. Studies in internal morphology of *Apis* (digestive and nervous systems), *Musca* (male and female reproductive systems), Grasshopper (nervous and reproductive system)
2. Mounting: wings mouth parts, antennae of insect pests (any three), genitalia of cockroach, bug, house fly / mosquito.
3. Preparation of key
  - a) Order level
  - b) Family levels for major orders
  - c) Collection and preparation of family level key of pests of major crops of North Bengal i.e. rice , jute, tea, vegetables
  - d) Identification of stored grain pests
4.
  - a) Quantification of water soluble protein in insects egg
  - b) Qualitative analysis of salivary and gut enzymes
  - c) Electrophoretic study of haemolymph ovarian and egg protein

### **Fisheries (Limnology aquaculture and fisheries) (DCE2-G)**

#### **Practical**

**Full Marks: 50**

1. Collection and identification of benthic organisms (fish ponds/streams)
2. Collection of Water and Soil samples from different water bodies for the following analysis:
  - i) Physico-chemical parameters of Water and Soil quality
  - ii) Primary Productivity
  - iii) Quantitative and qualitative estimation of phyto- and zoo- planktons
3. Microbial load (Plate Count and MPM technique)
  - iv) Determination of LC<sub>50</sub> at different hours of hill streams or rivers.
  - v) Determination of age in fish using scale

## **Stem Cell Biology and Regenerative Medicine (DCE2-H)**

### **Practical**

**Full Marks: 50**

1. Isolation of hematopoietic cells from mouse bone marrow, single cell preparation and determination of cellularity
2. Demonstration of marker based isolation of hematopoietic stem cells from flowcytometric data.
3. Determination of hematopoietic cell viability from murine marrow
4. Determination of lysosomal and mitochondrial health of murine bone marrow derived hematopoietic cells.
5. Photographic identification of different hematopoietic progenitor colony from the culture of murine marrow cells.
6. Determination of cellularity of extra-medullary hematopoietic organ (spleen/ liver) of mouse.
7. Histological study of murine bone marrow, extra-medullary hematopoietic organs (spleen and liver)
8. Demonstration of immunohistochemistry for the marker based identification of cancer stem cells in oral squamous cell carcinoma sample.

### **GE-1 P**

#### **Practical**

#### **Biophysics & Biostatics**

**Full Marks = 25**

1. Principle and handling of any one instrument frequently used in biological science research.
2. Learn different types of graphical representation of data in Excel (Bar, Line, Pie etc)
3. Learn how to calculate SD value and include SD values in Excel graph
4. Calculate P - value significance
5. Basic understanding of Two-way ANOVA for analysis of Variance

## **SEMESTER IV**

### **CORE T 110**

### **THEORY**

#### **Evolution Biology + Population Genetics**

#### **Group A**

#### **Evolutionary Biology**

**Full Marks = 25**

1. Origin of Life: Prerequisites for the origin of life, concept of Oparin and Haldane, Experiment of Miller, RNA world, Protocells
2. Emergence of evolutionary thoughts: Lamarck, Darwin-concepts of variation, adaptation, struggle, fitness and natural selection
3. Emergence of Non-Darwinism: Neutral Hypothesis.
4. Genes and phylogenetic relationships: Gene duplication and divergence, repetitive sequences, mitochondrial DNA, microsatellites, RFLPs, 16srRNA
5. Evolutionary phylogeny: homology, parallelism, convergence



6. Rate of molecular change: Molecular clock, Molecular drive
7. Speciation: Biological and Phylogenetic species concept, Patterns and Mechanism of reproductive isolation: Models of Speciation: Allopatric, Parapatric and Sympatric

**Group B            Population Genetics**

**Full Marks = 25**

1. Variation: Causes of Genetics Variation in natural population, Genetic polymorphism, Measures of Genetic variation.
2. Allele frequencies and Equilibrium: Hardy-Weinberg law-Assumption, Derivation and application in population genetics, Equilibrium at two or more loci and X-linked loci, Linkage disequilibrium
3. Destabilizing forces influencing allele frequencies:
  - a) Mutation and Estimation of mutation rates.
  - b) Natural Selection: Gametic Selection. Selection against recessive and recessive lethal, Selection against dominant, Heterozygote advantage.
  - c) Migration
  - d) Genetic Drift
  - e) Mutation-Selection Balance.
4. Genetic structure of population: Selection pressure, Fisher's Theorem of Natural Selection, Genetic load and Genetic death, Mutational load.
5. Inbreeding: Measure of inbreeding, Inbreeding depression, Heterosis.
6. Quantitative trait loci: Basic concept, Heritability and its estimation

**DCE 3-T**

**THEORY**

**Molecular Immunobiology and Immunogenetics (DCE 3A)**

**Theory**

**Full Marks = 50**

1. Molecular Genetics of Immunoglobulin: Allelic exclusions, recombination, rearrangements and assembly (RAG-1, RAG-2)
2. B Cell activation: B-lymphocytes Receptors, B-cell receptor-triggered signaling cascade and Activation
3. T cell activation: T-lymphocyte Antigen receptors, ITAM and initial signaling mechanism, Downstream signaling (Ras-MAPK, NF-KB) and activation, Co-stimulation regulation, Negative regulation (CTLA-4 and PD-1)
4. Molecular Genetics of Cancer: Oncogenic mutations in growth promoting proteins (e.g. EGF, PDGF, Ras Proteins, Src kinases, nuclear proteins), Retroviruses as vectors for oncogenes, Loss of Tumor suppressor genes, DNA viruses and associated tumours, mutations causing loss of cell cycle controls (e.g. p53, Bcl-2)
5. Cancer-specific antigens (encoded by mutant genes), Self- antigens (encoded by normal genes)

6. Effector mechanisms in Cancer Immunity: Role of Antibodies and B cells, T-lymphocytes, NK cells, LAK and NKT cells, Complement dependent and complement independent Ab mediated cytotoxicity, Macrophages and Granulocytes
7. Factors limiting Cancer immunity: Tumor microenvironment, Tumor immune escape mechanism, anergy and neonatal tolerance, Regulatory T cells, Blocking factors etc.
8. Immunotherapy for Cancer: Cancer Vaccines, Engineered antibodies, cytokines, Adoptive T-cell therapy
9. Modern Immunological techniques: Fluorescence in situ hybridization (FISH), Fluorescence Activated Cell Sorter (FACS), Microarray based mutation detection etc.

### **Molecular Cytology and Genetics (DCE-3B)**

#### **Theory**

**Full Marks: 50**

1. Genomics and Proteomics
  - a) Basic concept of system biology
  - b) Concept of transcriptome and proteome,
  - c) Global study of Genome activity: Analysis of transcriptome by SAGE and Microarray technique, Mass Spectrometry, Yeast two hybrid system, single cell genomics.
2. Cancer as a genetic disease: cell cycle regulation, oncogenic mutation, cancer therapy
3. Recombinant DNA Techniques: DNA sequencing, shotgun sequencing, next generation sequencing, DNA mobility shift assay, Western and Southwestern blotting
4. Application of Genetic techniques:
  - a) Mapping Genome: Linkage analysis in *Drosophila*.
  - b) Linkage mapping in pedigrees in human using DNA markers-Detection & Estimation of genetic linkage, Mapping of disease gene: Positional cloning & candidate gene approach strategy.
5. Molecular Pathology: Concept, Pathogenic mutation, Loss of function mutations, Gain of function mutation, Gene to disease approach, Disease to gene approach, Chromosomal approach.
6. Molecular genetics of Diseases: Fragile-X-Syndrome, Neurodegenerative diseases (Alzheimer, Parkinson, Multifactorial Schizophrenia)
7. Elementary idea of pharmacogenetics.

### **Molecular Cell Biology and Oncology**

**DCE 3C**

#### **Theory**

**Full Marks: 50**

1. Cancer and oncogenesis: Biology of cancer, oncogenic transformation, immortalization, cell behaviour. Primary vs Secondary tumours. Somatic mutations vs driver mutations.
2. Checkpoint Blockade: Checkpoint defects, in human cancers, checkpoint disruptors.
3. Angiogenesis and oncogenic signalling: Cancer stroma. Extracellular remodelling and metastasis. Signaling pathways in cancer.

4. Mitochondria, tumorigenesis and metabolic reprogramming: Cancer cell energetics, Warburg effect vs oxidative phosphorylation. EMT and endo-MT, role of oxidative stress and hypoxia in oncogenesis.
5. Tumor Immunology: Immune recognition and evasion, role of T cells, NK cells, TAMs and CAFs.
6. Concepts of chemoprevention, resistance and chemosensitization: Basic concepts and familiarization with common chemopreventive drugs like doxorubicin, cisplatin, etoposide, 5-FU, tamoxifen, paclitaxel, vincristine, vinblastine. Monoclonal antibodies against cancer. Basic idea of radiotherapy.
7. Modern Immunotherapy against Cancer: Basic idea about cancer immunotherapy.
8. Basic concepts of precision oncology and single cell genomics: Basic concepts and emerging applications.
9. Molecular Cell Biology Techniques: Promoter analysis by Luciferase assay, DNA mobility shift assay, Co-Immunoprecipitation and Chromatin Immunoprecipitation (ChIP) assay, SDS PAGE and immunoblotting, RNA interference/Genome editing.

### **Parasitology and Epidemiology with Artificial Intelligence Applications DCE 3D**

#### **Theory**

**Full marks: 50**

1. Helminth parasites, General characters, organization and larval forms of Platyhelminthes and Nematelminthes,
2. Distribution, habit and habitat, structure, life cycle and diseases caused by  
*Plasmodium falciparum*  
*Leishmania donovani*  
*Trypanosoma brucei/cruzi*  
*Fasciola hepatica*  
*Echinococcus granulosus*  
*Schistosoma haematobium*  
*Wuchereria bancrofti*
3. Epidemiology of diseases of public health importance and disease control
  - a) Chronic disease Epidemiology
  - b) Epidemiological aspects of diseases - Non-Communicable
  - c) Emerging and Re- Emerging diseases.
  - d) National Programmes related to Communicable and Non Communicable diseases
  - e) Dengue, Swine Flu, Chikungunya

4. Artificial Intelligence and Modelling of Biological Systems: Concepts and principles of modelling: Limitations of models, Models of behaviour, Modelling in Epidemiology and Public Health SIR models, Introduction to Artificial Intelligence –basics like non monotonic logic Planning Perception Learning Neural Networks Natural language processing Expert system.
5. Village Placement Programme  
Cooch Behar is a district of North Bengal where a majority of people lives below the poverty line. The rural mass is economically and educationally backward. Thus the aim of introduction of this village placement programme is to extend out to reach environmental awareness, hygiene and health to the rural people of this region on various aspects related to parasitic diseases. The students in their fourth semester have to visit any one of the village within the jurisdiction of CBPBU University and can arrange various programs to educate the rural mass in the following areas for three days.
  - a) Environmental awareness,
  - b) Hygiene and health
6. Bioethics and Medical ethics: Historical perspectives & Introduction to Bioethics, Ethics of clinical trials: Drug trials, vaccine trials.
7. Regulatory framework and guidelines for conduction of human research: Review processes, Institutional ethical committees, composition of committees, review procedures, WHO, UNESCO and ICMR guidelines.

#### **Ecology (Animal Behaviour)**

**DCE 3 E**

#### **Theory**

**Full marks: 50**

1. Survival value of Behavior: Experimental studies, Darwinian inclusive fitness.
2. Altruism: Kin-selection, reciprocal altruism, parental care, cooperation.
3. Role of environment in development of behavior: Interactive theory, early experience and behavioral development.
4. The nervous system and behavior: The nerve cell, sensory receptors, Neurobiology and behavior.
5. Behavioral genetics: a single gene effect, multiple gene effect, quantitative genetics, genetic techniques.
6. Mating system: Monogamy, polyandry without polygyny, polygyny.
7. Parental behavior and strategy: Rationale for greater involvement of the females, discriminating parental care, Evolution of parental favouritism.
8. Human behavior: Adaptionist approach, genetic difference and human behavior, IQ differences.

#### **Entomology (Insect Pest and Management)**

**DCE 3F**

#### **Theory**

**Full marks: 50**

1. Introduction to the pests of paddy, jute, mango, tea, timber and stored grains: Symptoms of their attack and crop damage.
2. Medical and forensic Entomology:
  - a) Vector biology: mode of transmission of pathogens by vectors & Controls strategies
  - b) Insects associated with cadavers with their medico-legal importance.
  - c) Poisonous insects

- d) Role of insects as decomposers
3. Concepts of economic entomology:
  - a) Pest surveillance, sampling methods of forecasting
  - b) Economic threshold and injury level
  - c) Determination of EIL & calculation of economic decision level
4. Concept of biological control of pests, application of molecular tools and techniques in control.
5. Host plant resistance, Transgenic resistance to pests
6. Molecular basis of insects biotypes, barcoding technique
7. Case histories of successfully implemented IPM
8. Quarantine and legislative measures for preventing spread of pests

**Fisheries (Fish Technology, and management)**

**DCE 3 G**

**Theory**

**Full marks: 50**

1. Crafts- Principal types of fishing crafts operated in Inland and Marine waters of India
2. Gears- Classification of fishing gears; Selection of fishing gears; Types of fishing gears used in Inland and Marine waters of India; Electro= fishing
3. Fish detection methods- Basic principles of Acoustic fish detection; Echo sounder and Sonar.
4. Fish Preservation- Fundamentals of biochemistry of fish; Principles & Methods of processing and preserving fish by Refrigeration, Freezing, Drying, Salt curing, Smoking, Pickling. Use of Refrigerated Sea Water (RSW). Common defects of preserved fish products. Modern techniques employed in fish preservation.
5. Canning technology: Definition of Canning; History and Principles underlying Canning process; Can manufacture; Sterilization; Canning process of fish and prawn in India; Common defects of Canned fish products.
6. Fish by-products and their economic importance.
7. Basic aspects of National Fisheries Policy
8. Fisheries Cooperative Society- Definition of Cooperative; Origin, Structure, Aims, Role and Problems of Fisherman's Cooperative Society (Inland & Marine).

**Stem Cell Biology and Regenerative Medicine**

**DCE 3 H**

**Theory**

**Full marks: 50**

1. Pillars of regenerative medicine – Cord blood- cellular composition, HSCs, MSCs and other cord blood derived stem cells, Ex-vivo expansion and differentiation of cord blood derived cells, clinical overview of cord blood transplantation and transfusion, importance of cord blood plasma and cord blood plasma factors (CBPF), use of Cord blood as true blood substitute, cord blood banking (CB collection, testing, processing and storage) and its importance; pregnancy specific biological substance (PSBS)- stem cells in placenta, amniotic membrane, amniotic fluid, therapeutic potentials of PSBS; therapeutic potential of fetal and non-fetal

(menstrual blood derived stem cells, endometrial stem cells, adipose derived stem cells, dental stem cells, breast milk stem cells)

2. Biomaterials in regenerative medicine – Selection of biomaterials for tissue engineering, Bio-scaffold and their design principles, Synthetic Biomaterials, Naturally occurring bio-scaffolds (collagen, chitosan, decellularized amniotic membrane)
3. Tissue engineering and its clinical application – Fundamentals of tissue engineering and regenerative medicine, Cell-biomaterial interaction, Biomimetic scaffolds, Use of nanoparticles in tissue engineering, ECM based hydrogels for tissue engineering, Liposomes and exosomes as tools of tissue engineering, 3D printing of organs, Concept of bio-ink in tissue engineering, Thermal inkjet printing in tissue engineering, Biomaterials regeneration of bone, cartilage, cardiovascular system, pancreas, liver, corneal tissue, urinary bladder, trachea, Regeneration of skin and scar less wound healing using stem cell and tissue engineering.
4. Clinical applications of stem cell and regenerative medicine –
  - Applications of stem cell in immunotherapy – MSCs as immune-modulators, application of stem cells for auto immune disorders, cancer immunotherapy
  - Application of stem cell in neurological diseases – Stem cell mediated therapies for Parkinson’s disease, cerebral stroke, multiple sclerosis, ALS, spinal cord injuries.
  - Applications of stem cell in hematological disorders – Potentialities of umbilical cord blood stem cells in treating different hematological disorders, comparison between HSCs derived from bone marrow and umbilical cord blood in treating hematological disorders, superiority of cord blood stem cells in treating malignancies of blood
  - Application of stem cells in scar less healing – Application of freshly collected amniotic membrane in treatment of non-healing foot ulcers (both diabetic and non-diabetic types), use of freshly collected amniotic membrane in treatment of burn, mechanism of scar less healing using stem cells and allied factors with emphasis on difference between repair and regeneration process.
5. Applications of stem cells and allied factors of cord blood and psbs in controlling inflammatory conditions – Role of cord blood in controlling cytokine storm in SARS-COV2 cases, role of cord blood in controlling cases of GVHD, potentiality of regenerative medicine in treating Inflammatory Bowel disease (IBD)

**Group A****Taxonomy****Full Marks = 25**

1. Concept of Species: Biological Species concept; supra and infraspecific groups,
2. Major characteristics used in taxonomy: Classical characteristics (Morphological, ecological, and physiological), Molecular characteristics (Comparison of proteins, chromosome painting, Nucleic acid base composition, nucleic acid hybridization, nucleic acid sequencing, DNA barcoding)
3. Numerical Taxonomy (Phenetics), Construction of Dendogram
4. Phylogentic classification (cladistics), Construction of phylogenetic trees, Cladograms (plesiomorphic, apomorphic, synapomorphic, symplesiomorphic, automorphies)
5. Zoological nomenclature: International code, Rules of nomenclature and its applicability

**Group B****Bioinformatics****Full Marks 25**

1. Introduction and scope of Bioinformatics
2. Major Biological databases and Information retrieval
3. Homology concept and alignment of pairs of sequence, Global and Logical Alignment
4. Basic local alignment search tool (BLAST), Other Blast options, PSI-BLAST
5. Application of BLAST tool
6. Multiple sequence alignment and its application
7. Introduction to Computational Gene Production and Genome annotation
8. Basic concepts in Computational Phylogenetic Analysis

**Core P 101****Evolution Biology + Population Genetics****Full Marks = 25**

1. Class to be divided into groups and each group shall be allotted a topic on the basis of which group discussion will be done. Evaluation will be done on the basis of individual performance.

**DCE 4 P****LABORATORY COURSES****Molecular Immunobiology and Immunogenetics (DCE 4 A)****Practical****Full Marks:50**

1. Cancer cell line maintenance *in vitro* and *in vivo*
2. Induction of solid tumors, staining and identification of ascitic tumor cells
3. DNA isolation; Primer designing (*in silico*) and PCR technique

4. Agarose gel electrophoresis and SDS PAGE
5. Estimation of cytokines by ELISA (demonstration)
6. Demonstration of Immuno-blotting/ Immunohistochemistry
7. Brief idea on Cell cycle analysis by flowcytometry and Interpretation of FACS results
8. Institutional visit (Optional)- Marks to be added for CE in case it is carried out.

### **Molecular Cytology and Genetics (DCE 4 B)**

#### **Practical**

**Full Marks:50**

1. Genomic DNA isolation from blood (human), tissue (mice) and quantitation
2. Isolation of plasmid DNA
3. Restriction digestion of Plasmid/Genomic DNA and electrophoresis. Plasmid mapping
4. PCR amplification of known DNA
5. Demonstration: Southern blotting and hybridization
6. Institutional visit (Optional)- Marks to be added for CE in case it is carried out.

### **Molecular Cell Biology and Oncology (DCE 4 C)**

#### **Practical**

**Full Marks:50**

1. Cancer cell culture.
2. Viability assay by Trypan blue dye exclusion microscopy.
3. Immunohistochemistry/immunocytochemistry demonstration.
4. Protein isolation, quantification, SDS PAGE and Western blotting
5. Institutional visit (Optional)- Marks to be added for CE in case it is carried out.

### **Parasitology (DCE 4 D)**

#### **Practical**

**Full Marks:50**

1. Life cycle studies of parasites: Protozoans, Nematodes, Helminths
2. Fluorescence/ Immunofluorescence microscope studies on parasite tissues
3. Cryosectioning / Preservation/mounting of parasite tissues
4. Estimation of RNA in tissue (Colorimetric method)
5. Feulgen reaction method for DNA localization
6. Localization of RNA by methyl green pyronin –‘Y’
7. Polymerase chain reaction (Demonstration)
8. RFLP Analysis (Demonstration)
9. Biological Sequence analysis- Analysis of DNA and protein sequence
10. Modeling in Epidemiology and Public Health SIR models
11. AI applications in epidemiology-Any two
12. Institutional visit (Optional)- Marks to be added for CE in case it is carried out.

### **Ecology and Animal Behaviour (DCE 4 E)**

#### **Practical**

**Full Marks:50**



1. Study of primary productivity of a pond using light and dark bottles
2. Physico-chemical analysis of pond water
3. Succession of bacterial population in milk
4. Population studies of *Tribolium* spp.
5. Study in field/zoo/institute. Marks to be added for CE in case it is carried out.

**Entomology (DCE 4 F)**

**Practical**

**Full Marks:50**

1. a) Host plant/seed preference study
  - b) Quantitative assay of damage of host leaf/seed caused by pest
  - c) Estimation of biochemical changes in host plant/seed due to pest injury
2. a) study of insects population density (anyone species)
  - b) comparison of variance of populations of a pest species from different location and different time
  - c) determination of LD<sub>50</sub>/ LC<sub>50</sub> values of pesticides using a pest species
  - d) Studies in species RTU/ family level diversity of insect community from crop/forest/grassland/ soil habitat
3. a) Study of life cycle of pest/vector
  - b) Submission of stages of life cycle of insects and mite pests of any crop of North Bengal
4. Visit to institution/ experimental plot/ field for acquiring advanced knowledge in entomology (Optional). Marks to be added for CE in case it is carried out.

**Fisheries (Limnology aquaculture and fisheries) (DCE 4 G)**

**Practical**

**Full Marks:50**

1. Collection and identification of benthic organisms (fish ponds/streams)
2. Collection of Water and Soil samples from different water bodies for the following analysis:
  - a) Physico-chemical parameters of Water and Soil quality
  - b) Primary Productivity
  - c) Quantitative and qualitative estimation of phyto- and zoo- planktons
  - d) Microbial load (Plate Count and MPM technique)
  - e) Determination of LC<sub>50</sub> at different hours of hill streams or rivers.
  - f) Determination of age in fish using scale
3. Collection and identification of Commercially important Fishes- Inland including hill streams and Marine water.
4. Study of bucco-pharyngeal region, gill-rakers, and the alimentary canal of local fishes to determine their food and feeding habits.
5. Pituitary gland extraction from head of Carp and Cat fishes and its preservation
6. Determination of Calorific Value of Fish Muscle using Wet- oxidation Method
7. Aquarium management: Setting of aquaria; fabrication; maintenance; breeding and rearing of ornamental fishes. Common diseases and their control measures.
8. Field or Institutional visit (Optional)- Marks to be added for CE in case it is carried out.

## **Stem Cell Biology and Regenerative Medicine (DCE 4 H)**

### **Practical**

**Full Marks:50**

1. Determination of RBC count, WBC count, platelet count, reticulocyte count, hemoglobin estimation, differential blood cell count of peripheral blood/ cord blood sample.
2. Mallory`s trichrome staining to identify the endosteal layer of bone marrow and sub-epithelial matrix of oral mucosa.
3. Preparation of single cell and viability determination from amniotic membrane.
4. Histological study of Umbilical cord and placenta.
5. Photographic identifications of different artificial scaffolds.
6. Institutional visit (Optional)- Marks to be added for CE in case it is carried out.

## **Taxonomy & Biosystematics + Bioinformatics GE-2 P**

### **Practical/Seminar**

**Full Marks:25**

Project/ Review/Seminar/ on Taxonomy & Biosystematics and Bioinformatics

## UPDATED MSC. ZOOLOGY SYLLABUS, CBPBU

Sem	Paper code (Theory-T & Practical-P)	Paper Name	Theo (T)	CE	Attendance	Total	Credit	Pract. (T)	Viva/ Seminar	Credit	Total Marks	Total Credit
Sem 1	Core (T101 & P-101)	Functional Biology of Nonchordates + Chordates	50	20	5	75	4	25		1	100	5
	Core-(T-102 & P-102)	Biochemistry +Environmental Physiology	50	20	5	75	4	25		1	100	5
	Core-(T-103 & P-103)	Ecology +Animal Behaviour	50	20 (Field Visit Report)	5	75	4	25		1	100	5
	Core- (T-104 & P-104)	Developmental Biology + Endocrinology	50	20	5	75	4	25		1	100	5
Sem 2	Core-(T-105 & P-105)	Genetics + Biotechnology	50	20	5	75	4	25		1	100	5
	Core-(T-106 & P-106)	Cell Biology + Neurobiology	50	20	5	75	4		25 (Seminar & Manuscript submission)	1	100	5
	Core- (T-107 & P-107)	Immunology + Viral & Microbial Pathology	50	20	5	75	4	25		1	100	5
	Core-(T-108 & P-108)	Parasitology + Insect Biology	50	20	5	75	4	25		1	100	5
Sem 3	Core-(T-109 & P-109)	Biodiversity & Wildlife + Aquaculture and Fisheries Resources of India	50	20	5	75	4		25 (Field Visit Report)	1	100	5
	DCE-1	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ Stem Cell	50	20	5	75	3		25 (Review/ Dissertation/ Training Prog. - Manuscript submission)	2	100	5

		Biology and Regenerative Medicine <b>(Theory)</b> -anyone to be chosen										
	DCE-2	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ Stem Cell Biology and Regenerative Medicine <b>(Practical)</b> / -anyone to be chosen	20	5	25	3	50	25 (Seminar on Review/ Dissertation/ Training Prog.)	2	100	<b>5</b>	
	GE-1	Biophysics + Biostatistics/ (few will be added later on during syllabus upgradation)	50	20	5	75	4	25	1	100	<b>5</b>	
Sem 4	Core-(T-110 & P-110)	Evolutionary Biology +Population Genetics	50	20	5	75	4	25 (Group Discussion)	1	100	<b>5</b>	
	DCE-3	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ Stem Cell Biology and Regenerative Medicine <b>(Theory)</b> anyone to be chosen	50	20	5	75	3	25 (Review/ Dissertation/ Training Prog. Manuscript submission)	2	100	<b>5</b>	
	DCE-4	Molecular Immunobiology & Immunogenetics // Molecular Cytology & Genetics/Molecular Cell Biology & Oncology/ Parasitology and Epidemiology with Artificial Intelligence Application / Ecology/ Entomology / Fisheries/ Stem Cell Biology and Regenerative Medicine <b>(Practical)</b> anyone to be chosen		20	5	25	3	50 ( Seminar on Review/ Dissertation/ Training Prog)	2	100	<b>5</b>	
	GE-2	Taxonomy & Biosystematics + Bioinformatics ( few will be added later on during syllabus upgradation )	50	20	5	75	4	25 (Seminar)	1	100	<b>5</b>	
											1600	<b>80</b>