Undergraduate and Postgraduate syllabus
Department of Biological Science
Presidency University, Kolkata

The Department of Biological Science in Presidency University has been created by merging together the pre-existing Departments of Botany, Zoology, Physiology, Molecular Biology, Biochemistry and Biotechnology. The result is a dynamic interdisciplinary Department with a holistic approach towards the study of Biological Science. The department consists of outstanding faculty who are eminent in their fields, and have joined the University after successful research and teaching careers. The mixture of young and experienced faculty in the Department of Biological Science promises an outstanding academic experience to its students. They will have the opportunity of learning a multitude of inter-disciplinary subjects, and will also have research experience by the completion of their studies. In the curriculum, there will be two semesters in each academic year and thus a student enrolled in the Bachelor of Science program will leave with a Bachelors Degree in Biological Science after completion of Six semesters. Students who have completed a B.Sc Honours in any branch of Biological Science can enroll for the M Sc program which consists of Four semesters of curriculum. All students enrolled in the Bachelor of Science program will study the same compulsory course modules in the first three semesters (Semester 1, 2 and 3) and these modules will comprise mostly of the fundamentals of Biological Science, ranging from diversity and evolution to biochemistry and genetics. There will be laboratory based / field study based practical modules related to the theoretical papers. The objective is to generate the knowledge base of the students, upon which they will build up their education. Upon completion of Semester 3, students will have the liberty of choosing theory papers of their personal interest, with the corresponding laboratory modules or they can opt for subject specialization. An advisory committee of Departmental faculty will assist each student at this stage to select their courses for semesters 4, 5 and 6 based on their interests and their future career goals. Similarly, in the M.Sc program, first two semesters (PG Semester 1 and 2) will comprise of a common core syllabus studied by all students. In the 3rd and 4th semesters of post graduate programme, students would have to select a subject specialization. An advisory committee will assist the students at this stage as well. Every student enrolled in the Master's program has to complete a research project in their final semester (PG Semester-4) as part of the curriculum. The successful students will be awarded with an M.Sc degree in Biological Science, with their transcripts mentioning the course names.

The total number of theory and practical modules that a student can take during UG semester -4,5,6 and PG semester-3 & 4 will be based on UGC guidelines. The Department will reserve the right to limit the number of students for a particular module as well as fix the combinations of modules offered during the said semesters, wherein preference will be given to the merit.

The structure of the curriculum and the details are provided below.

CURRICULUM STRUCTURE OF BIOSCIENCE

UG SEMESTER-1

BIOS 0101 (Theoretical): Plant and Animal Diversity, Organic Evolution and Ecology [50 marks; 4 credits]
Part 1: Plant and Animal Diversity [20 marks]
Part 2: Organic evolution [15 marks]
Part 3: Ecology [15 marks]

BIOS 0191 (Practical): Plant and Animal Diversity, Organic Evolution and Ecology [50 marks: 6 credits]
Part 1: Plant and Animal Diversity
Part 2: Organic Evolution
Part 3: Ecology
Part 4: Histology
Part 5: Local excursion
Part 6: Group discussion by students

UG SEMESTER-2

BIOS 0201 (Theoretical): Biophysical Principles, Biochemistry and Biostatistics [50 marks; 4 credits]
Part 1: Biophysical Principles [15 marks]
Part 2: Biochemistry [20 marks]
Part 3: Biostatistics [15 marks]

BIOS 0291 (Practical): Biophysics, Biochemistry and Biostatistics [50 marks; 6 credits]
Part 1: Biophysics
Part 2: Biochemistry
Part 3: Biostatistics
Part 4: Group discussion by students

UG SEMESTER-3

BIOS 0301 (Theoretical): Cell Biology, Molecular Biology and Genetics [50 marks; 4 credits]
Part 1: Cell Biology [15 marks]
Part 2: Molecular Biology [20 marks]
Part 3: Genetics [15 marks]

BIOS 0302 (Theoretical): Microbiology, Biology of Diseases and Immunology [50 marks; 4 credits]
Part 1: Microbiology [15 marks]
Part 2: Biology of Diseases [15 marks]
Part 3: Immunology [20 marks]

BIOS 0391 (Practical): Cell Biology, Molecular Biology, Genetics, Microbiology and Immunology [50 marks; 6 credits]

Part 1: Cell Biology
Part 2: Molecular Biology
Part 3: Genetics
Part 4: Tissue Staining
Part 5: Microbiology
Part 6: Immunology
Part 7: Group discussion by students

SUBJECT BASKETS FOR SEMESTER 4, 5, 6

Following modules will be offered in the basket. A candidate will be given option to choose the modules accordingly so that the required credit as per the following format is achieved. The Advisory committee can guide a candidate regarding choosing of the modules if anyone desires to restrict him/herself to any specialization. The Department will reserve the right to limit the number of students for a particular module as well as fix the combinations of modules offered during the said semesters , wherein preference will be given to the merit.

UG SEMESTER -4

Modules offered: Candidates would have to take **two** theoretical modules (**one each** from **BIOS 0401** and **BIOS 0402**), each of 4 credits, and **one** corresponding practical, of 6 credits.

BIOS 0401 (A-E) (Theoretical Optional - choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0401A	Plant architecture and systematics
2	BIOS 0401B	Functional morpho-anatomy of non-chordates
3	BIOS 0401C	Enzymology
4	BIOS 0401D	Digestion, nutrition, excretion and thermal homeostasis
5	BIOS 0401E	Industrial microbiology

BIOS 0402 (A-F) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0402A	Evolutionary and applied plant biology
2	BIOS 0402B	Functional morpho-anatomy of chordates
3	BIOS 0402C	Applied nutrition and dietetics
4	BIOS 0402D	Maintenance, expression and regulation of the genome
5	BIOS 0402E	Blood, body fluids, hematology, cardiovascular system and respiration
6	BIOS 0402F	Microbe- man interaction: beneficial and harmful aspects

BIOS 0491 (Practical corresponding to BIOS 0401 and BIOS 0402 options)

[25 + 25= 50 marks; 6 credits]

UG SEMESTER -5

Modules offered: *Candidates would have to take **three** theoretical modules (**one each** from **BIOS 0501, BIOS 0502 and BIOS 0503**) ; each of 4 credits, and **two** corresponding practicals, of 6 credits each.*

BIOS 0501 (A-D) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0501A	Fungal diversity, plant disease management
2	BIOS 0501B	Animal physiology, parasitology, vector biology and evolution
3	BIOS 0501C	Bioenergetics, intermediary metabolism
4	BIOS 0501D	Environmental microbiology

BIOS 0502 (A-D) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0502A	Gymnosperms; paleobotany and palynology,_Ethnopharmacology in drug discovery
2	BIOS 0502B	Taxonomy and adaptation; wildlife biology and ethology
3	BIOS 0502C	Nervous system, physiology of nerve and muscle, sensory physiology
4	BIOS 0502D	Fundamentals of Genetic Engineering

BIOS 0503 (A-E) (Theoretical Optional-choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0503A	Endocrinology, neuroendocrinology and human reproduction
2	BIOS 0503B	Behavioral and cognitive neuroscience
3	BIOS 0503C	Fundamentals of cell biology
4	BIOS 0503D	Microbial ecology and food microbiology
5	BIOS 0503E	Basic immunology

BIOS 0591 **(Practical corresponding to BIOS 0501,0502 and 0503 theoretical options)**

[50 marks; 6 credits]

BIOS 0592 **(Practical corresponding to BIOS 0501,0502 and 0503 theoretical options)**

[50 marks; 6 credits]

UG SEMESTER - 6

Modules offered: *Candidates have to take **three** theoretical modules (**one each** from **BIOS 0601, BIOS 0602 and BIOS 0603**); each of 4 credits, and **two** corresponding practicals, of 6 credits each.*

BIOS 0601 (A-C) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0601A	Plant physiology
2	BIOS 0601B	Biostatistics and bioinformatics
3	BIOS 0601C	Applied immunology

BIOS 0602 (A-D) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0602A	Plant biotechnology and plant breeding
2	BIOS 0602B	Biophysical methods
3	BIOS 0602C	Social physiology, stress physiology, ergonomics and sports physiology
4	BIOS 0602D	Animal histology, animal development and economic zoology

BIOS 0603 (A-B) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents
1	BIOS 0603A	Pathophysiology of common human diseases and pharmacological drug design
2	BIOS 0603B	Fundamentals of genetics

BIOS 0691 (Practical corresponding to BIOS 0601,0602 and 0603 theoretical options)

[50 marks; 6 credits]

BIOS 0692 (Practical corresponding to BIOS 0601,0602 and 0603 theoretical options)

[50 marks; 6 credits]

PG SEMESTER -1

BIOS 0701 (Theoretical) [50 marks; 4 credits]
Methods and Experimental Design

BIOS 0702 (Theoretical) [50 marks; 4 credits]
Part 1- Advanced Cellular Biology [25 marks]
Part 2- Developmental Biology [10 marks]
Part 3- Fundamentals of Neurobiology [15 marks]

BIOS 0703 (Theoretical) [50 marks; 4 credits]
Part 1- Advanced Biochemistry [25 marks]
Part 2- Advanced Molecular Biology [25 marks]

BIOS 0791 (Practical corresponding to BIOS 0702) [50 marks; 4 credits]
BIOS 0792 (Practical corresponding to BIOS 0703) [50 marks; 4 credits]

PG SEMESTER – 2

BIOS 0801 (Theoretical) [50 marks; 4 credits]
Part 1- Advanced Microbiology [25 marks]
Part 2- Immunology [25 marks]

BIOS 0802 (Theoretical) [50 marks; 4 credits]
Part 1-Advanced Genetics [30 marks]
Part 2- Environmental Science [20 marks]

BIOS 0803 (Theoretical) [50 marks; 4 credits]
Part 1- Research conduct and Bioethics [20 marks]
Part 2- Emerging field of Science [30 marks]

BIOS 0891 (Practical corresponding to BIOS 0801) [50 marks; 4 credits]
BIOS 0892 (Practical corresponding to BIOS 0802) [50 marks; 4 credits]

PG SEMESTER -3

PG Semester 3 and 4 will be for specialization. The following modules will be offered to the students. Advisory Committee will guide regarding selection of modules to any candidate to aid with specialization. The Department will reserve the right to limit the number of students for a particular module as well as fix the combinations of modules offered during the said semesters , wherein preference will be given to the merit.

Modules offered: *Candidates would have to take **three** theoretical modules (**one each** from **BIOS 0901, BIOS 0902 and BIOS 0903**), each of 4 credits, and the corresponding practicals, of final 12 credits.*

Credits to be achieved as follows:

BIOS 0901 (A-E) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents	Credits
1	BIOS 0901A	Animal structure and function	4
2	BIOS 0901B	Molecular biology and biochemistry of diseases	4
3	BIOS 0901C	Alimentary, Neuromuscular, Cardiovascular Physiology and Biostatistics	4
4	BIOS 0901D	Plant systematic; Plant anatomy and pharmacognosy	2+2 = 4
5	BIOS 0901E	Palaeobotany and palynology; Plant pathology	2+2 = 4

BIOS 0902 (A-E) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents	Credits
1	BIOS 0902A	Animal taxonomy, ecology, evolution and behavior	4
2	BIOS 0902B	Current trends and advances in cell and molecular biology	4
3	BIOS 0902C	Applications of biophysical methods in Biology	4
4	BIOS 0902D	Respiratory, Excretory, Endocrine, Reproductive Systems and Biorhythms	4
5	BIOS 0902E	Plant Physiology, crop improvement and molecular plant breeding	2+2 = 4

BIOS 0903 (A-E) (Theoretical Optional- choose **any one** from the following modules**)**

[50 marks; 4 credits]

Serial #	Module	Course contents	Credits
1	BIOS 0903A	Animal physiology and animal development	4
2	BIOS 0903B	Advanced macromolecular structure, function and dynamics	4
3	BIOS 0903C	Medical Microbiology	4
4	BIOS 0903D	Sports physiology, Man and environment (work and stress) and sensory physiology	4
5	BIOS 0903E	Plant biotechnology and Intellectual Property Rights	2+2

			= 4

BIOS 0991 (Practical corresponding to BIOS 0901, BIOS 0902 and BIOS 0903 theoretical options) [50 marks; 4 credits]
BIOS 0992 (Practical corresponding to BIOS 0901, BIOS 0902 and BIOS 0903 theoretical options) [50 marks; 4 credits]

PG SEMESTER-4

This semester will cover the dissertation projects and project related topics as well as developing research skills as preparation for PhD.

BIOS 1001 (Theoretical) [50 marks; 4 credits]
Understanding trends in Modern Biology Research (Journal Club)
BIOS 1002 (Theoretical) [50 marks; 4 credits]
Project related theory
BIOS 1003 (Theoretical) [50 marks; 4 credits]
Review of literature
BIOS 1091 (Practical) [50 marks; 4 credits]
Project related lab
BIOS 1092 (Practical) [50 marks; 4 credits]
Dissertation (30 marks) and oral presentation (20 marks)

*Candidates have to take **any one** from the following theoretical modules; each of 4 credits*

Serial #	Module	Course contents	Credits
1	BIOS 1002A	An experimental approach to the study of Biomolecules	4
2	BIOS 1002B	Animal Science and Environmental Biology	4
3	BIOS 1002C	Plant and Microbial Genetic Engineering	4
4	BIOS 1002D	Human Physiology	4
5	BIOS 1002E	Recombinant DNA technology and downstream processing	4

DETAILED SYLLABUS OF BIOSCIENCE

UG SEMESTER-1

BIOS 0101(Theoretical): Plant and Animal Diversity, Organic Evolution and Ecology

Part 1: Plant and Animal Diversity

1. **Classification of plant phyla:** Overview of classification with diagnostic features and economic importance (upto 'class' in case of algae, fungi, bryophytes, pteridophytes and gymnosperms and upto 'family' in case of angiosperms).
2. **Classification of animal phyla:** Classification of extant major phyla (upto 'class' in case of invertebrates and upto 'order' in case of vertebrates).
3. **Plants with structural and functional specializations:** Transition of plants from aquatic to land habit, origin of seed habit, heterotrophy and heterothallism in fungi**,** Special adaptations in angiosperms- Insectivorous plants, parasitic plants, halophytic plants, endophytes
4. **Structural and functional specializations in animals:** Polymorphism in *Siphonophora*, bioluminescence in firefly, accessory respiratory organ in fishes, electric organ in fishes, neoteny in *Axolotl* larva, poison gland and biting mechanism in poisonous snakes, echolocation in bat, echolocation in dolphin.
5. **Elements of Human System Physiology I:** Basic system biology of human: outline of Alimentary, Circulatory, Nervous and Excretory system.
6. **Elements of Human System Physiology II:** Basic system biology of human: outline of Endorine, Reproductive, Homeostasis and Integrative physiology.

Part 2: Organic evolution

1. **Origin of life:** Abiotic origin of life with reference to Miller's experiment, physical and chemical catalysis of formation of macromolecules, Oparin's 'proteinoid droplet' concept and Crick's 'Nucleic acid first' hypothesis.
2. **Geological era:** Climatic, floral and faunal characteristics of different geological era.
3. **Classical theories of evolution:** Critical review of Lamarckism, Darwinism and mutation theory of de Vries.
4. **Synthetic theory of evolution:** Basic concept with reference to Hardy-Weinberg equilibrium in populations and factors destabilizing such equilibrium (mutation, migration, genetic drift).
5. **Other concepts of evolution:** Goldschmidt's concept of micro- and macroevolution; Gould and Eldredge's 'punctuated equilibrium hypothesis'.
6. **Isolating mechanisms, allopatric speciation and sympatric speciation:** Basic concepts.

Part 3: Ecology

1. **Ecosystem function:** Energy flow in ecosystem, energy vs. eMergy, food chain, food web and ecological pyramids; Productivity in terrestrial and aquatic ecosystems.
2. **Population Ecology:** Characteristics of population, population growth curves, *r* and *k* selections, population regulation by density-dependent and density-independent factors, concept of self-regulation of population.

3. **Community Ecology: Habitat** and niche concept; Keystone species and dominant species; Ecotone and edge effect; Heterospecific associations with reference to competition, protocooperation, commensalism and mutualism.
4. **Ecological succession:** Causes, types and process, climax concept, theories on ecological succession.
5. **Pollution Biology and impact on human:** Air pollution - source and effect of major air pollutants, greenhouse gases and greenhouse effect, ozone hole, physical and chemical control of air pollution; Water pollution - major causes and consequences with special reference to arsenic pollution in West Bengal; Sound pollution and its auditory and non-auditory effects. Stress physiology and physiological consequences.

BIOS 0191 (Practical): Plant and Animal Diversity, Organic Evolution and Ecology

Practicals based on theoretical syllabus.

UG SEMESTER-2

BIOS 0201 (Theoretical): Biophysical Principles, Biochemistry and Biostatistics

Part 1: Biophysical Principles

1. **Forces stabilizing atomic and molecular interactions:** Formation, properties and biological significance of Van der Waals force, hydrogen bond, ionic bond, covalent bond and hydrophobic interaction.
2. **pH and buffer:** Derivation of upper and lower limits of pH; Biological significance of pH; Characteristics of buffer; Deduction of Henderson-Hasselbalch equation of pH of buffer; Principal buffers of extracellular and intracellular fluids and their function.
3. **Colligative properties of solutions:** Osmosis and osmotic pressure; Van't Hoff's laws and determination of osmotic pressure; Isosmotic and istotonic solutions; Effect of hyper- and hypotonic media on cells; Survival of marine and freshwater fishes in their respective hyper- and hypotonic environments; Depression of freezing point and Raoult's laws; Cryoscopic constant and determination of its value; Survival of polar fish at subzero temperature.
4. **Thermodynamics, reaction kinetics and energy transduction:** Isolated, closed and open systems; First and second laws of thermodynamics and their biological significance; Activation energy and transition-state theory; Different orders of chemical reactions, free energy and chemical reaction; Mitochondrial electron transport chain and oxidative phosphorylation; Photophosphorylation.

Part 2: Biochemistry

1. **Carbohydrate chemistry:** Classification and properties of carbohydrates with emphasis on stereoisomerism, optical isomerism, epimerization, mutarotation and reducing action of sugars.
2. **Protein chemistry:** Classification of proteins; primary, secondary, tertiary and quaternary structure of proteins; Properties of proteins with emphasis on isoelectric pH, salting in and out, biuret test and heat coagulation.
3. **Lipid chemistry:** Classification and properties of lipids with emphasis on saponification number, iodine number, acetyl number, Reichert-Meissel number, hydrogenation and rancidity of fats.
4. **Nucleic acid chemistry:** elementary concept of nucleoside, nucleotide, polynucleotide; elementary concept of RNA

Part 3: Biostatistics

1. **Introduction to Biostatistics:** Variable and attribute; Population vs. sample; Census vs. sample survey; Arrangement of data; Frequency distribution.
2. **Presentation of data:** Line diagram; Bar diagram; Pie chart; Histogram etc.
3. **Measures of central tendency:** Arithmetic mean; Mode; Median.
4. **Measures of dispersion:** Variance; Standard deviation; Standard error of mean; Standard score.
5. **Testing of hypothesis:** Null hypothesis, Level of significance, Probability, Normal distribution, Error of inference, Student's t-test, Paired t-test.
6. **A brief idea on correlation, regression and experimental design.**

BIOS 0291 (Practical): Biophysics, Biochemistry

Practicals based on theoretical syllabus.

UG SEMESTER-3

BIOS 0301 (Theoretical): Cell Biology, Molecular Biology and Genetics

Part 1: Cell Biology

1. **Cell structure:** Structural uniqueness of prokaryotic, plant and animal cells; structural organization of the cell wall, plasma membrane; importance of membrane bound organelles.
2. **Brief introduction to cytoskeleton:** Cellular organisation of the Cytoskeleton, microtubules, microfilaments, intermediate filaments
3. **The cytoplasmic organelles and their functions:** Mitochondria;Chloroplast; ER; Golgi complex; Lysosome, Endosome, Ribosome;; Nucleus. Transport of molecules across membranes, intracellular junctions.
4. **Chromosomes, chromatin and nucleosome:** Chromosome structure in bacteria and eukaryotes, centromere, telomere, Hetero- and euchromatin, Nucleosome model and radial-loop scaffold model.
5. **Overview of Cell cycle:** Stages of cell cycle, Mitotic and meiotic cell division; Distinction between mitosis in plant and animal.

Part 2: Molecular Biology

1. **DNA as genetic material**: experimental evidence, different forms of DNA (A, B, Z) , comparative analysis of structural features of DNA and RNA
2. **The Central Dogma**
3. **Replication:** Brief overview of synthesis of DNA in prokaryotes
4. **Transcription**: Brief overview of synthesis of RNA in prokaryotes
5. **Translation**: Genetic code and its properties, Brief overview of protein synthesis in prokaryotes

Part 3: Genetics

1. **Model organisms in genetic analysis:** Contributions of model organisms like *E. coli,* yeast, *Neurospora, Arabidopsis*, Maize, , *Drosophila*, *C. elegans*, Zebra fish
2. **Mendelian Genetics:** Mendelian Laws and chromosome theory of inheritance, extension of Mendelism
3. **Allele concept:** Dominant, recessive and co-dominant alleles; Muliple allelism with reference ABO blood group; Pseudoallelism with reference to eye colour in Drosophila.
4. **Linkage, Crossing Over and Chromosome Mapping in Eukaryotes:** Coupling and repulsion phase of linkage; linkage group, complete and incomplete linkage, cytological proof of crossing over, recombination mapping with a two and three-point testcross; coincidence and interference

5. **Mutation and mutagens:** Basic features and molecular basis**,** Diverse types of point mutations, Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements - deletion, duplication, inversion and translocation, mutagenic action of common physical and chemical mutagens.

BIOS 0302 (Theoretical): Microbiology, Biology of Diseases and Immunology

Part 1: Microbiology

1. **Microbial diversity:** cellular (bacteria, algae, fungi, protozoa) and acellular (virus) microbes, polyphasic bacterial taxonomy, extremophiles.
2. **Architecture of bacteria and virus:** comparison between eubacteria and archebacteria **.**
3. **Microbial nutrition, growth and its control:** Nutritional requirements in bacteria and nutritional categories, different types of cultural media, microbial culture, kinetics of microbial growth.
4. **Microbial replication strategy:** bacteria and virus (lytic, lysogenic cycle)
5. **Genetic recombination in bacteria:** basic concept of: transformation, conjugation, and transduction, gene mapping by interrupting mating technique.
6. **Basics of microbial pathogenesis:** host, pathogen, pathogenicity factors, Koch's postulates, parasitism and synergism.
7. **Microbial control:** concepts on β-lactam antibiotics and their mode of action.

Part 2: Biology of Diseases

Common diseases of plants (Late blight of Potato, Bacterial blight of rice,Black stem rust of wheat), animals, humans (obesity, diabetes, cardiovascular diseases, AIDS, common viral diseases): a mechanistic overview.

Part 3: Immunology

1. **Overview of immune system**
2. **Cells and organelles of immune system**
3. **Immunity in plants:** Defensive role of ethylene, lignin, callose, tannin, hydrogen peroxide and lectin-enzyme complex in plants; Phytoalexin vs. antibody.
4. **Elements of immunity in animals:** Innate vs. acquired immunity; Passive vs. active immunity
5. **Antigenicity of molecules:** Immunogen vs. antigen; Characteristics and types of antigens; Epitope, Adjuvants and Haptens.
6. **Immunoglobulins:** Molecular structure and classification
7. **Antigen-antibody reaction:** Principle and a few basic application of antigen-antibody reaction

BIOS 0391 (Practical): Cell Biology, Molecular Biology, Genetics, Microbiology, Immunology

Practicals based on theoretical syllabus.

UG SEMESTER-4

BIOS 0401A (Plant architecture and systematics)

Morphology:

1. Inflorescence: Types with examples.

2. Flower: Types; Parts-Calyx (modification), Corolla (Forms and aestivation), Stamen (adhesion and cohesion, attachment of anther), Carpel (apocarpous and syncarpous), Placentation (types) Ovules (types and structure).
3. Fruit: Types and examples.
4. Pollination: Types, contrivances.

Anatomy:

1. Apical meristem: Organization of shoot-apex (Tunica-Corpus), root-apex (Korper-Kappe) concept.
2. Stomata: Types (Metchalfe and Chalk), Ontogeny.
3. Stele: Types and Evolution.
4. Root-Stem transition & its significance.
5. Mechanical Tissue: Types, ontogeny of trachery elements & sieve elements
6. Secondary growth: Normal (intra- and extra-stelar), Anomalous (with common examples)

Plant systematic: classical to molecular approach:

1. Nomenclature*:* Elementary knowledge of ICBN: Concept of taxa; categories and hierarchy; species concept (taxonomic, biological, evolutionary); principles and rules of nomenclature; ranks and names; type method, author citation, valid publication; rejection of names, principle of priority and its limitation; names of hybrids and cultivars.
2. Classification*:* Broad outline of Bentham and Hooker (1862-1883) and Angiosperm Phylogeny Group (APG) Classification.
3. Molecular, chemo and cyto taxonomy, Characters and attributes; Operational Taxonomic Units (OTU), character weighing and coding; cluster analysis, phenograms, cladistics, Chloroplast, nuclear and mitochondrial DNA markers.
4. Diagnostic features of representative primitive and advanced families of monocots and dicots.

Practicals based on theoretical syllabus.

BIOS 0401B (Functional Morpho-anatomy of Non-chordates)

1. Feeding, reproduction and locomotion in Protozoa.
2. Aquiferous system and endoskeleton in Porifera.
3. Coral and coral reef formation
4. Locomotion and excretion in Annelida
5. Respiration and excretion in Arthropoda. Anatomical peculiarities, affinities and systematic position of *Peripatus, Limulus*
6. Nervous system and respiration in Mollusca.
7. Water vascular system in Echinodermata.
8. *Balanoglossus* - anatomy, affinities and systematic position
9. Structure and significance of trochophore, crustacean larvae, glochidium, echinoderm larvae and tornaria.
10. Minor phyla with reference to Ectoprocta and Entoprocta.

Practicals based on theoretical syllabus.

BIOS 0401C (Enzymology)

1. **Basics of enzymology**: Definition, examples of holoenzymes, Apoenzyme.
2. **Cofactors**: definition, examples of a) metal ions b) coenzymes c) prosthetic group
3. **Classification of enzymes**: IUPAC system, Name and examples of each class
4. **Enzyme Kinetics**: concept of enzyme catalysis: active site, activation energy and Arrhenius concepts, specificity of enzymes-geometric and stereo specificity with example, lock and key

hypothesis, induced fit hypothesis, derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of K_m and V_{max} and their physiological significances. Importance of K_{cat}/K_m. Kinetics of zero and first order reactions. Classification of multi-substrate reactions with examples of each class. Ping Pong, random and ordered Bi-Bi mechanisms.

5. **Quantitative assay of enzyme activity**: Unit of enzyme activity, specific activity, molecular activity/turnover number, molar activity, katal.

6. **Factors affecting enzyme catalyzed reaction**: concentration, temperature, pH, time and cofactors.

7. **Inhibition of enzyme catalyzed reaction**: reversible and irreversible inhibition, linear-mixed type inhibitions and their kinetics, Suicide inhibitor.

8. **Mechanism of Enzyme Action**: Enzyme catalysis- acid-base, covalent and metal ion catalysis, proximity-orientation effect, strain and distortion theory. Experimental approaches to determine the mechanism of enzyme action. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde-3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase.

9. **Variation from classical types:** Isozymes with examples, abzymes, synzymes, non-protein enzymes.

10. **Regulation of enzymes**: allosterism, sequential and concerted model, feedback inhibition and feed-forward stimulation, reversible (glutamine synthase and phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Monocyclic and multicyclic cascade systems with specific examples; flip flop mechanism.

Practicals based on theoretical syllabus.

BIOS 0401D (Digestion, Nutrition, Excretion and thermal homeostasis)

1. **Alimentary system:** Anatomy and histology of alimentary canal. Digestive glands – Deglutition and Movements of alimentary canal and their regulations. Composition, functions and regulation of the secretion of salivary, gastric, pancreatic and intestinal juices and bile. Synthesis of Bile acids. Enterohepatic circulation. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Feces and defecation. GALT. Basic concepts of Peptic Ulcer, Jaundice and Gallstones.

2. **Nutrition and Dietetics:** Nutrition, health and malnutrition; Constituents of food and their significance. Basal metabolic rate -factors, determination by Benedict Roth apparatus. Respiratory quotient. Specific dynamic action. Calorific value of foods. Body calorie requirements – adult consumption unit. Dietary requirements symptoms of deficiency and excess. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance. Biological value of proteins, supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins; Dietary fibers. Principle of diet survey. Composition and nutritional value of common foodstuffs. Physiology of starvation and obesity. Elementary idea of glycaemic index; functional foods, nutraceuticals, probiotics and food supplements.

3. **Renal physiology:** Anatomy of kidney; Histology of nephron. Renal circulation – Formation of urine. Countercurrent multiplier and exchanger. Renal regulation of osmolarity and volume of blood fluids. Diabetes insipidus. Formation of hypertonic urine. Renal regulation of acid-base balance, acidification of urine. Renal function tests. Physiology of urinary bladder and micturition. Composition of urine. Abnormal constituents of urine, renal dialysis. Non-excretory functions of kidney.

4. **Skin and body temperature regulation:** Structure and functions of skin. Cutaneous circulation. Sweat glands Sweat formation, secretion and its regulation. Insensible perspiration. Regulation of body temperature in homeotherms, pyrexia, hyperthermia and hypothermia. Concept of Q10.

Practicals based on theoretical syllabus.

BIOS0401E (Industrial Microbiology)

1. General concepts of industrial microbiology, Principles of exploitation of microorganisms and their products.
2. Idea of Fermentation, Cell growth, Metabolism, Regulation of Metabolism, Substrate Assimilation / Product Secretion. Different fermentative system. Batch and Continuous processes, Surface and Submerged liquid substrate Fermentation, Solid substrate Fermentations.
3. Industrial fermentations - Fermentor Design, Types of Bioreactors, Recovery and purification of intracellular and extracellular products, Fermentation Raw Materials, Down Stream Processing, Bio Mass Production.
4. Food Fermentation (Alcohol, Cheese, Bread, Soya based food, Meat Fermentation, Vinegar).
5. Microbial production of lactic and citric acid, steroids, vitamin B12, lysine, α-amylase, β-amylase, protease, lipase.
6. Production of genetically modified food, agar agar, alginates, diatomaceous earth. Production of Industrial Solvents (Acetone, Butanol), Nutraceuticals.
7. Concepts of Immobilized Enzymes.

Practicals based on theoretical syllabus.

BIOS 0402A (Evolutionary and applied plant biology)

1. Cyanobacteria: life history, ecology, importance, evolutionary significance.
2. Microbes in agriculture: Biofertilizers - Bacterial, Cyanobacterial and Azolla. Mass production of *Rhizobium* and *Azotobacter*.
3. Environmental microbiology: degradation of cellulose, hemicelluloses, lignin.
4. Food microbiology: principles of food preservation- Asepsis, Removal of microorganisms, anaerobic condition - High and low temperature, Drying, Food additive. Canning, contamination and spoilage of canned food.
5. Applied microbiology: Industrial production of cheese and ethanol, bread making, single cell protein.
6. Microbial production of lactic and citric acid, lysine, α-amylase, β-amylase, protease, griseofulvin.
7. Plant microbe interaction- biological nitrogen fixation, nif gene, nod factor, mycorrhizal fungi and strigolactone signaling, evolution of parasitism in plant-genomic aslect, endosymbiotic theory, endophytic plants-molecular aspect
8. Endosymbiotic theory: origin of plastid. Origin and evolution of sex in algae.
9. Origin of Bryophyte (algal and pteridophytic hypothesis). Origin of alteration of generation.
10. Applied Bryology: Biotechnological and pharmacological significance.
11. Telome theory of Zimmerman and Enation theory of Bower.
12. Apospory and Apogamy, origin of seed habit

Practicals based on theoretical syllabus.

BIOS 0402B (Functional Morpho-anatomy of Chordates)

1. Affinities and systematic position of *Dipnoi*
2. Comparative account -Lamprey and Hagfish, Elasmobranchii and Teleostomi, *Lacertilia* and *Ophidia*, *Ratitae* and *Carinatae*
3. Filterfeeding in protochordates; progressive and retrogressive metamorphosis in Chordata
4. Anatomy and affinities of sphenodon
5. Aerodynamics of bird flight.
6. Air sacs and double respiration in birds
7. Affinities and systematics of Monotremata and Marsupialia
8. Exoskeletal structure in amniotes.
9. Comparative anatomy of heart and aortic arch
10. Comparative anatomy of kidney
11. Ruminant stomach
12. Migration in fish and bird

Practicals based on theoretical syllabus.

BIOS 0402C (Applied nutrition and Dietetics)

1. Nutrition, malnutrition and health: concept, definition and scope.
2. Constituents of food and their significance. Minimum energy requirement and RDA. Energy requirement in humans, basal metabolic rate -factors, determination by Benedict Roth apparatus. Respiratory quotient. Specific dynamic action. Calorific value of foods. Body calorie requirements – adult consumption unit; Dietary requirements of carbohydrates, proteins, lipids and other nutrients. Growth and development from infancy to childhood.
3. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance. Essential fatty acids, PUFA, MUFA; Essential amino acids. Proteins sparers. Supplementary value of protein. Protein efficiency ratio, net protein utilization of dietary proteins, Biological value of proteins. Dietary fibers.
4. Principles of diet survey. Composition and nutritional value of common food stuffs. Physiology of starvation and obesity. Elementary idea of functional foods,
5. Neutraceuticals, Probiotics and food supplements.
6. Malnutrition – PCM, marasmus, kwashiorkor, arasmickwashiorkor. Endemic goiter, nutritional anemias, rickets, osteomalacia, xeropthalmia, beriberi, anaemia, rickets; Implications of diabetes, CHD**.**
7. Concept of community nutrition, nutritional assessment and surveillance; nutritional assessment by nutritional anthropometry and diet survey; Nutritional intervention programs; food borne diseases; Basic concept of diet therapy.

Practicals based on theoretical syllabus.

BIOS 0402D (Maintenance, expression and regulation of the genome)

1. **Organization of the genome:** Organization of bacterial genome. Structure of Eukaryotic genomes, non-repetitive and repetitive DNA sequences, Mitochondrial DNA organization, Chloroplast genome organization.
2. **DNA Replication, Recombination and Repair:** Chemistry of DNA synthesis, Mechanism of DNA Replication in prokaryotes, Replication errors and repair, DNA damage and repair, Homologous recombination, site specific recombination and Transposition of DNA, Mutations.

3. **Transcription and post-transcriptional processing**: RNA polymerase and the transcription cycle in bacteria, Spliceosome machinery, alternative splicing, exon shuffling, RNA editing, mRNA transport, a brief overview on transcription in eukaryotes.
4. **Translation:** Translation mechanism in prokaryotes, The Genetic Code, Codon Anticodon interaction, Ribosomes, A brief overview on Protein Synthesis in Eukaryotes.
5. **Regulation of gene expression:** Operon concept with reference to lac operon and trp operons in *E. coli*; Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, regulation of gene expression during development, role of chromatin in regulating gene expression and gene silencing.
6. **Molecular Biology techniques:** Kinetics of qualitative and quantitative PCR with special reference to SYBR green and Taqman technology, primers and probes, cloning and expression vectors with examples, GATEWAY and TA cloning systems, Gel blotting and hybridization technologies (Southern, Northern, Western, In situ), genomic, cDNA and expression library preparation, colony hybridization, library screening, different types of promoters and concept of TFBS.

Practicals based on theoretical syllabus.

BIOS 0402E (Blood, Body Fluids, Hematology, Cardiovascular system and Respiration)

1. **Blood and body fluids:** Bone marrow. Formed elements of blood. Plasma proteins Haemoglobin: types, abnormalities, biosynthesis and catabolism. Different types of anaemia and their causes. Blood volume; Hemostasis –factors, mechanism, anticoagulants. Disorders of hemostasis; Blood group; Blood transfusion and its hazards. Lymph and tissue fluids; Lymphatic organs.
2. **Physiology Of Heart:** Anatomy of the heart. Properties of cardiac muscle. Cardiac action potential; cardiac impulse. The cardiac cycle-Heart sounds. Cardiac output-Electrocardiography –the normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vectorcardiogram, the mean electrical axis of heart. The His bundle electrogram. Principles of Echocardiography. Cardiac Arrhythmias –Myocardial Infarctions. Cardioplegic solutions.
3. **Vascular Physiology:** Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids. General pattern of circulation; the pulse – Hemodynamics of blood flow; Blood pressure – factors affecting. Cardiac and vasomotor centers, baroreceptors and chemoreceptors, cardiac and vasomotor reflexes. Cardiovascular homeostasis.
4. **Regional circulation:** Cerebral, Coronary, Hepatic, Splanchnic and skeletal muscle circulation.
5. **Pathophysiology of circulation**: Haemorrhage, Hypovolemic and hypervolemic shock. RTI and atherosclerosis.
6. **Physiology of respiration:** Anatomy and histology of the lung and airways. Mechanics of breathing -- Lung volumes and capacities. Alveolar surface tension and surfactant, work of breathing. Ventilation- perfusion ratio Dead space and uneven ventilation. Spirometry. Pulmonary circulation. Transport of gases in body. Partial pressure and composition of normal atmospheric gases in inspired, expired, alveolar airs and blood. Oxygen dissociation curve of hemoglobin and myoglobin – factors affecting. Carbon dioxide dissociation curve. Regulation of respiration -neural and chemical, respiratory centers, chemoreceptors, baroreceptors, pulmonary receptors. Hypoxia – Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema. Lung function tests. Artificial respiration. Concept of non-respiratory functions of lung, normal values, origin and functions.

Practicals based on theoretical syllabus.

BIOS 0402F (Microbe- Man interaction: beneficial and harmful aspects)

1. Normal microbial flora of human body, opportunistic pathogens, use of probiotics.
2. General attributes and virulence factors of bacteria causing infections.
3. Bioterrorism with examples (anthrax, small pox), Biological Weapons Convention.
4. History of discovery of microbes as potential therapeutic agents.
5. Production of pharmaceutical compounds through microbes - hormones, diagnostic proteins.
6. Pharmaceutically valuable microalgae, pigments and H2 gas from cyanobacteria.
7. General mechanisms for antibiotic action, antibiotic resistance, resistance mechanisms, significance. Resistance Tests. Combination therapy: Significance, side effects.
8. Bacteriocins: mode of action of some common bacteriocins; difference with antibiotics and uses. Antifungal agents: examples and sites of action of some commonly used antifungal agents, Antiviral and anti-parasitic drugs.

Practicals based on theoretical syllabus.

UG SEMESTER 5

BIOS 0501A (Fungal diversity and plant disease management)

Fungal diversity

1. Understanding fungi: cellular composition, growth parameters.
2. Diversity and evolution in fungal reproduction- from asexual to sexual, factors affecting sporulation, dispersal, dormancy and germination.
3. Sexual compatibility in fungi, heterokaryosis and parasexuality in advanced fungi.
4. Economically important fungi and their propagative cycles
   i) Pathogenic *Phytophthora*, *Puccinia* and *Fusarium*.
   ii) Industrially important Rhizopus and Saccharomyces..
   iii) Medically important *Penicillium.*
   iv) Experimental *Ascobolus.*
   v) Nutritionally important *Agaricus*.
5. Fungi as predators, parasites and saprophytes.
6. Mycorrhiza as a unique symbiotic association between plants and fungi. Beneficent role of mycorrhiza. Mycorrhiza as fertilizer.
7. Lichens as pollution biomarkers. Structural biology of lichen thallus, including reproduction. Lichens as pioneers in ecological succession

Plant disease management:

1. Brief introduction about the history of plant pathology: concept of plant pathogen interactions, Koch's postulates, Importance of plant pathology.
2. Mechanism of infection by bacterial and fungal pathogen. Pre-penetration, Penetration and Post-penetration mechanisms).
3. Structural plant defense mechanisms- preexisting and post infection. Genetic modifications for enhancing structural defense.
4. Biochemical defense employed by plants for preventing infection. Preexisting biochemical defense. The hypersensitive response as an induced biochemical defense. Role of antimicrobialslike PR proteins, phytoalexins.
5. Plant immunity and plantibodies.
6. Plant disease management strategies, including integrative disease management. ..

7. Diseases of economically important crop plants and their control- Wheat Rusts, Rice Blights, Tobacco Mosaic disease.

Practicals based on theoretical syllabus.

BIOS 0501B (Animal physiology, parasitology and vector biology)

Group – A (Animal physiology)

1. Respiratory pigments and respiratory gas transport in animals
2. Osmoregulation in vertebrates
3. Thermoregulation in poikilotherms and homeotherms

Group – B (Parasitology and vector biology)

1. Interspecific interaction – symbiosis, mutualism, commensalism and parasitism.
2. Parasitic adaptations.
3. Protozoan and helminth parasites – life cycle, pathogenicity and control.
4. Characteristic feature of vector organism.
5. Mosquito, sand fly, tick and mite as a vector.

Group – C (Evolution)

1. Genetical basis of evolution with special emphasis on founders effect, population bottleneck
2. Concept of distribution - Barrier, Discontinuous distribution, Zoogeographical realm

Practicals based on theoretical syllabus.

BIOS 0501C (Bioenergetics and metabolism)

Group A - Bioenergetics (15 marks)

Biochemical reaction mechanism; Temperature dependency from Arrhenius law; Theoretical prediction of rate constant: Interpretation of batch kinetic data; analysis of intra-particle diffusion and reaction; Kinetics of substrate utilization, product formation and biomass production; Chemical mechanisms of biological energy conversion in mitochondria and chloroplasts, Photosynthesis energy transfer kinetics; DNA base recognition and replication fidelity; Gibbs Free Energy; Protein folding and stability; Ligand binding; Protein-Protein and Protein-DNA interactions; Osmosis, Dialysis

Group B-Intermediary metabolism (35 marks)

Unit I: Carbohydrate and Energy metabolism

1. Introduction: Concept of metabolism, catabolism, and anabolism, experimental approach to study of metabolism using intact animals, bacterial mutants, and radioactive isotopes.

2. Carbohydrate metabolism: Intracellular metabolism of glucose - glycolysis, reaction and energetic of TCA cycle, gluconeogenesis, glycogenesis, glycogenolysis, reactions and physiological significance of pentose phosphate pathway, regulation of glycolysis,TCA cycle, and glycogen metabolism. Photosynthesis- light and dark reaction (in C3, C4 and CAM), photorespiration.

3. Oxidative phosphorylation and electron transport chain: Structure of mitochondria, sequence of electron carriers, ATP synthesis, inhibitors of ETC, basic concept of oxidative phosphorylation, inhibitors and uncouplers of oxidative phosphorylation, photophosphorylation.

Unit II: Metabolism of non-carbohydrates

4. Lipid metabolism: Metabolism (anabolism and catabolism) of triglyceride, Transport of fatty acid into mitochondria, Beta-oxidation of fatty acids, reactions and energetic of beta oxidation,

biosynthesis of saturated and unsaturated fatty acids, metabolism of ketone bodies, biosynthesis of phospholipids and cholesterol.

5. Amino acid metabolism: general reactions of amino acid metabolism (oxidative deamination, transamination, decarboxylation etc), glucogenic and ketogenic amino acids, urea cycle, biosynthesis and catabolism of amino acids (glycine, phenylalanine, glutamic acid), inborn errors of amino acid metabolism.

6. Nucleotide metabolism: Biosynthesis and catabolism of purines and pyrimidines (Adenine and cytosine).

7. Porphyrin metabolism: Biosynthesis and degradation of porphyrins, biosynthesis of bile pigments.

Practicals based on theoretical syllabus.

BIOS 0501D (Environmental Microbiology)

1. **Microbial population dynamics**: commensalism, synergism, mutualism, competition, amensalism, predation, parasitism.
2. **Role of microbes in the food chain**: carbon cycling.
3. **Soil microorganisms and their association with vascular plants**: phyllosphere, *Rhizobium*, Rhizoplane associative nitrogen fixation.
4. **Biofertilizers**: Bacterial, Cyanobacterial and *Azolla*.
5. **Biopesticides**: Bacterial, Viral and Fungal.
6. **Aquatic Microbiology:** Ecosystems - Fresh water (ponds, lakes, streams - marine - estuaries, mangroves, deep sea). Water zonations, eutrophication - food chain, potability of water - microbial assessment of water quality, water purification - water borne diseases (typhoid fever, giardiasis) and preventive measures.
7. **Biological Waste Treatment**: Types of wastes - characterization of solid and liquid wastes. Waste treatment and useful byproducts, solid waste treatment- saccharification - gasification - composting - liquid waste treatment - aerobic, anaerobic methods.

Practicals based on theoretical syllabus.

BIOS 0502A (Gymnosperms; Palaeobotany, Palynology and Ethnopharmacology in drug discovery)

1. Diagnostic features of Gymnosperm, bioactive compounds obtained from Gymnosperms, whole genome sequencing of conifer and the major evolutionary conclusions drawn.
2. Palaeobotany: The evolutionary time scale and dominant plant groups; Eras, periods and epoch; Major events in the evolutionary time scale; concept of plant fossils, Principles of nomenclature (concept of genera and form genera)
3. Palynology: Microgametogenesis, pollen dispersal and pollination, taxonomic classification of spores, pollen wall- sporopollenin, pollen viability, application of palynology in human health and forensic sciences
4. Forensic botany: Application of anatomy, pollen biology and DNA fingerprinting –few case studies

Ethnopharmacology in drug discovery:

1. Ethnopharmacology: concept; as source of lead natural products with clinical significance.
2. Traditional healing in global context, Ethnobotany and Ethnozootherapeutics, survey, data collection, documentation, science behind the folklore.
3. Pharmacologically active constituents, source plants, parts used and uses of Steroids (Diosgerun. Digitoxin). Tannin (catechin), Resins (Gingerol, Curcuminoids) Alkaloids (Quinine, Strychnine,

Reserpine, Vinblastine). Human uses of plant secondary metabolites and foods as medicines: nutraceuticals

Practicals based on theoretical syllabus.

BIOS 0502B (Taxonomy and Adaptation; Wildlife Biology and Ethology)

Group – A (Taxonomy and adaptation)

1. Concept of systematics and taxonomy, alpha, beta and gamma taxonomy, phenon, taxon, taxonomic category, Linnean hierarchy
2. Principles and theories of animal classification
3. Nomenclature of animal taxa and International code of zoological nomenclature
4. Different species concept, their merit and demerits
5. Adaptations in animals – primary and secondary aquatic adaptation, primary and secondary volant adaptation, cursorial adaptation, arboreal adaptation, fossorial and desert adaptation.
6. Adaptive radiation in vertebrates

Group – B (Wild life biology and Ethology)

1. Biodiversity – different levels and values of biodiversity, threats to biodiversity, biodiversity hotspots.
2. Animal conservation – aims, in-situ and ex-situ strategies of conservation
3. Wild life sanctuary, National park, Biosphere reserve
4. Threatened and endangered animals of India
5. International bodies for conservation with reference to red data book
6. Conservation of Tiger and Rhino India
7. Concept of innate and learning behavior
8. Eusociality and Elements of social behaviors in animals (selfishness, altruism, kinship and cooperation)
9. Communication – channels of communication, bee dance, role of pheromone in regulating communication.
10. Parental care in fish and amphibian.

Practicals based on theoretical syllabus.

BIOS 0502C (Nervous system, physiology of nerve and muscle, sensory physiology)

1. **Physiology of muscle**: Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle. Muscle groups: antagonists and agonists. Properties of skeletal muscle: excitability, contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Optimal load, optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation: Excitation- contraction coupling. Dihydropyridine receptors and Ryanodine receptors. Mechanical components of muscle. Isometric and isotonic contractions –Chemical, thermal and electrical changes in skeletal muscle during contraction and relaxation. Electromyography.
2. **Physiology of nerve:** Structure, classification and functions of neurons and neuroglia. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential, action potential,

electrotonic potentials, current of injury and compound action potential. Propagation of nerve impulse in different types of nerve fibers.

3. **Properties of nerve fibers:** Indefatigability, Synapses: types, structure, synaptic transmission of the impulse synaptic potentials. Neurotransmitters, cotransmitters, and neuromodulators. The neuromuscular junction: structure, transmission, end-plate potential, MEPP and post-tetanic potentiation. Motor unit and Motor point. Injury to peripheral nerves –degeneration and regeneration in nerve fiber, changes in the nerve cell body, Thermal changes of nerve during activity. Nerve growth factors.
4. **Organization of nervous system:** A brief outline of organization and basic functions (sensory, motor and association) of the nervous system (central and peripheral). Structural organization of different parts of brain and spinal cord.
5. **Reflex action**: definition, reflex arc, classification and properties Autonomic nervous system: organization, outflow, ganglia, centers and functions. Chemical transmission and central control of autonomic nervous system. CSF: formation, circulation and functions Blood-CSF and Blood-Brain barrier. AMPA receptors, GABA, opiate, serotonin, dopamine and histamine receptors.
6. **Sensory receptors and functional properties:** Classification of general and special senses. Receptors as biological transducers. Muller's law of specific nerve energies. Weber-Fechner law, Steven's power law. Sensory transduction in Pacinian corpuscle. Adaptation of receptors.
7. **Physiology of Olfaction and Gustation:** Structure and functions of the receptor organs, nerve pathways, centers. Properties of olfactory and gustatory sensation and their transduction and coding. Electro-olfactogram (EOG). Abnormalities of olfactory and taste sensation.
8. **Acoustic physiology:** Sound waves, decibel. Structure and function of auditory apparatus Organ of Corti. Auditory transduction. Auditory pathways and centers. Mechanism of hearing and its modern theories. Different electrical potentials of internal ear. Discrimination of sound frequency and loudness. Localization of sound source. Audiometry, Deafness.
9. **Physiology of vision**: Structure of the eyeball. Structure of lens. Formation of cataract and glaucoma. Mechanism of accommodation. Pupillary reflexes, light reflex, near response. Errors of refraction and their corrections. Histological details of retina, peripheral retina, fovea and blind spot. Retinal detachment. Visual pathway and centers. Effects of lesion in visual pathway. Photopic and scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual processing in the retina. Electroretinogram. Positive and negative after- images. Contrast phenomenon. Light and dark adaptation. Color vision and its modern concept. Color blindness. Visual field-perimetry. Visual acuity –factors affecting. Critical fusion frequency (CFF).

Practicals based on theoretical syllabus.

BIOS 0502D (Fundamentals of Genetic Engineering)

1. Molecular tools for gene cloning: Nucleases, Methylases, Polymerases, Ligases, Topoisomerases, End Modifying Enzymes

2. Vectors and gene cloning: Introduction to cloning vectors , Desirable properties of vectors , Prokaryotic & Eukaryotic Expression Systems, Plasmid Vectors , Phage Vectors, Cosmids, Phagemids , BACs, Yeast Vectors, YACs , Lentiviral Vectors , Adenoviral Vectors , Plant Vectors, Insect Vectors

3. Advanced techniques in molecular biology: PCR and its variants, Gel Electrophoresis and Blotting Techniques, Methods of gene transfer in Plants and Animals: Chemical, Physical & Viral mediated DNA transfer; Construction of Genomic & cDNA Libraries, DNA Sequencing, gene knock out in bacterial and eukaryotic organisms

4. **Antisense and Ribozyme technology:** Conditional Knock-down systems, gene silencing, antisense strategies, ribozymes and siRNAs, RNA interference

5. **Applications of recombinant DNA technology:** Agriculture related applications, Medicine related applications, Microbial applications, environment-related applications, Livestock improvement.

Practicals based on theoretical syllabus.

BIOS 0503A (Endocrinology, Neuroendocrinology and human reproduction)

1. **Biology of Informational Molecules:**
   i) Classification of endocrine glands and hormones. Methods of study of endocrine functions.
   ii) Growth factors –EGF, TGF, PDGF, IGF and FGF. Chemical nature, mode of action, functions.
   iii) Regulation of secretion of the hormones.
2. **Receptors and Bio signaling:** Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme coupled. Intracellular messengers – cAMP, cGMP, IP3, DAG, Protein kinases, Ca^{++}, CO, NO. Signal transduction pathways – Phosphatidylinositides, MAP kinase, JAK-STAT, SMAD. Intracellular receptor- structure-function relationship.
3. **Neuroendocrinology:** Hypothalamus as a neuroendocrine organ. Pineal gland – histological structure. Chemical nature, biosynthesis, mode of actions, functions and regulation of secretion of melatonin.
4. **Role of Hormones in Metabolism:** Anterior and posterior pituitary -- histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland. Thyroid and parathyroid -- Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands. Thymus -Adrenal cortex and medulla -- Chemical nature functions and regulation of secretion of the cortical hormones. Biosynthesis and catabolism of catecholamines. Heart as an endocrine organ. Prostaglandins and Kinins. Pancreatic islets -- Chemical nature, mode of action, and functions of hormones secreted diabetes mellitus. Gastro-intestinal hormones – source and functions.
5. **Biology of Human Reproduction:** Physiology of puberty. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions. Histology of ovary. Ovarian hormones and their functions and control. Oogenesis, folliculogenesis and ovulation. Corpus luteum and leuteolysis. Estrous cycle. Menstrual cycle Onset of menopause and post-menopausal changes. Fertilization, Preliminary ideas of implantation. Structure and functions of placenta. Maintenance of pregnancy and the bodily changes during pregnancy. Pregnancy tests. Parturition. Mammogenesis, Galactopoesis: Hormonal control.

Practicals based on theoretical syllabus.

BIOS 0503B.(Behavioral and cognitive neuroscience)

1. **Cognitive neuroscience and higher functions:** Limbic system: structure, connections and functions. Physiology of emotion. Electrophysiology of brain: spontaneous electrical activity of brain, EEG and ECoG, evoked potential, DC potential. Isolated cortex. Higher functions of nervous system: conditioning, learning, short-term and long-term memory. Speech and Aphasia. Asymmetrical organization of certain cognitive functions-split brain. Reticular formation: organization, connection and functions of ascending and descending reticular formation. Physiological basis of sleep and wakefulness.

2. **Molecular neurobiology:** General concept of ionotropic and metabotropic receptors. Structure, sub-types, and functions of nicotinic and muscarinic acetylcholine receptors. Adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors.

3. **Neural pathways:** Ascending and descending tracts: origin, courses, termination and functions. Lower and upper motor neurones. Functions of the spinal cord with special reference to functional changes following hemisection and complete section of spinal cord – Brown-Sequard syndrome, Spinal animal. Pain production, perception and regulation. Referred pain.

4. **Neural homeostasis and concept of Cyberatics:** Decerebrate rigidity, Decorticate rigidity, Postural reflexes and regulation of Posture. Muscle spindle and Golgi tendon organ: their structure, innervations and functions, regulation of muscle tone. Structure, connections and functions of cerebellum. Structure and functions of vestibular apparatus. Nuclei, connections and functions of thalamus and hypothalamus. Basal nuclei: structure, connections and functions. Cerebral cortex: histological structure, localization of functions. Concept of cybernatics.

5. **Biological rhythms and Human system**: Different types of physiological rhythms – ultradian, circadian, infradian. Different zeitgebers and their relation with circadian clock. Hormonal biorhythms and their significance: adrenocortical, pineal and prolactin. Body temperature rhythm. Neural basis of biological clock and role of supra chiasmatic nuclei. Sleep-wakefulness cycle. Time keeping genes. Jet lag and shift work.

Practicals based on theoretical syllabus.

BIOS 0503C (Fundamentals of Cell Biology)

1. **Origin of eukaryotic cell**: Endosymbiotic hypothesis and its recent status.
2. **Membrane structure and function**: Structure of model membrane; ion channels; ion pumps; active transport; mechanism of sorting and regulation of intracellular transport; electrical properties of membrane.
3. **Cellular transport:** Brief outline of protein targeting to Mitochondria, Chloroplast, Endoplasmic reticulum and Nuclear transport; Protein modifications, Folding, Vesicular transport, Secretion, Endocytosis, Autophagy and protein degradation pathways, nuclear transport..
4. **Cell Architecture**: Cytoskeleton and its components – Organization and properties of Microfilaments, Intermediate filaments and Microtubules; Molecular motors.
5. **Basic experimental techniques**: Use of light and electron microscopes in cell biology.
6. **Cellular communication**: Brief idea about signaling molecules and receptors; an overview of different signaling pathways.
7. **Cell division and Cell death**: Different phases of Cell cycle; MPF; Checkpoints in Yeast and Mammalian cell cycle; Stem cells- properties; Preliminary idea of Programmed Cell Death.
8. **Cancer** : Preliminary idea of Oncogene, Proto-oncogene and Tumor suppressor gene.

Practicals based on theoretical syllabus.

BIOS 0503D (Microbial ecology and food microbiology)

Group A: Microbial ecology

1. **Importance of Microbial Ecology**.
2. **Microbiology of the Extreme Environment** - Microbial life in hyper saline environments – eco-physiological aspects, sea and salt lakes; Microbial life at low temperatures, deep sea and space.
3. **Extremophilic microbes and their applications**– Halophiles, Thermophiles, Barophiles.

4. **Anaerobic Microorganisms** – eco-physiological aspects, principles and techniques for the isolation, enumeration and identification of Methanogens, Dissimilatory Sulphate reducing and Anoxygenic Phototrophic bacteria.
5. **Geo-microbiological processes** – physiological and biochemical aspects, Methods in Geo-microbiology.

Group B: Food microbiology

1. **Importance of microorganisms in food microbiology** - mold yeast and bacteria - General characteristics, classification and importance.
2. **Principles of food preservation** - Asepsis, Removal of microorganisms, anaerobic condition - High and low temperature, Drying, Food additive. Canning, contamination and spoilage of canned food.
3. **Food and water borne diseases** – Gastroenteritis, Botulism, Salmonellosis, bacterial toxins in spoiled food, Detection of food borne pathogen.
4. **Microbiology of milk** - pasteurization - various types of microbiological analysis of milk. Contamination and spoilage of milk and milk products.
5. **Microbial cells as food-** SCP, mushroom cultivation.

Practicals based on theoretical syllabus.

BIOS 0503E (Basic Immunology)

1. Innate immunity– Pattern recognition receptors, PAMP, DAMP, cellular mechanism of innate immune receptors (TLRs, RLRs, etc.), Complement system
2. Organization, expression and regulation of immunoglobulin genes; generation of antibody diversity and class switching
3. B and T cell receptors; signal transduction mechanisms
4. MHC – gene and protein structure and function
5. Antigen processing and presentation, antigen presenting cells
6. B lymphocytes and T lymphocytes – types, maturation & activation
7. Cytokines

Practicals based on theoretical syllabus.

UG SEMESTER 6

BIOS 0601A (Plant physiology)

Group A: Plant Physiology:

1. Water and Plant cells-Water transport processes in plants, Water balance of plants. The Soil-Plant-Atmosphere continuum.
2. Solute transport: Passive and Active transport, Ion transport in roots.
3. Translocation in the phloem: Pathways, patterns and mechanism of translocation.
4. Mineral nutrition: Essential nutrients, deficiencies and plant disorders.
5. Plant hormones – Strigolactone Biosynthesis, storage, breakdown and transport
6. Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement.
7. Dormancy and senescence.
8. Stress Physiology: Responses of plants to abiotic stress- osmotic stress, temperature stress, oxidative stress.

Group B: Plant Embryology and development:

1. Gametogenesis in Angiosperms - Microsporogenesis - Megasporogenesis - Ovule ontogeny - types - Embryo sac – synergid.
2. Pollination: Syngamy, Triple Fusion, Post Fertilization.
3. Endosperm: Ultra structure - Types - Histogenesis and Organogenesis of monocot and dicot embryos.
4. Seed germination-role of alpha amylase and gibberellin
5. Polyembryony: Apomixis – Parthenogenesis
6. Leaf Development-Abaxial and adaxial identity
7. Cell differentiation- non-cell autonomous signaling in plant development
8. Role of cytokinesis in pattern formation.
9. Genetics of flower development- ABC model

Practicals based on theoretical syllabus.

BIOS 0601B (Biostatistics and Bioinformatics)

Biostatistics

1. Overview of testing of hypothesis, errors of inference and distribution types.
2. Distribution-free test - Chi-square test, G-test.
3. Product moment Correlation- assumptions, properties, computations and applications, Spearman's rank correlation coefficient, Point biserial r, Biserial r, contingency coefficient.
4. Properties and computations of simple linear regression.

Bioinformatics

Introduction to Genomic Data and Data Organization. Sequence Data Banks – Introduction to sequence data banks – protein sequence data bank, NBRF-PIR, SWISSPORT, Nucleic Acid sequence data bank – GenBank, EMBL. Structural data bank – protein data bank, SCOP and CATH, The Cambridge Structural database (CSD); Genome data bank – Metabolic pathway data; Microbial and cellular data banks, Sequence Analysis – Analysis tools for sequence data banks, Pair–wise alignment – NEEDLEMAN AND WUNSCH ALGORITHM, SMITH WATERMAN. Multiple alignments – CLUSTAL, BLAST, FASTA algorithm to analyze sequence pattern, motifs and profiles.

Practicals based on theoretical syllabus.

BIOS 0601C (Applied Immunology)

1. Effector mechanisms of T cells and B cells / Humoral and cell mediated immunity
2. Autoimmunity
3. Hypersensitivity disorders
4. Vaccination versus passive immunization; types of vaccines; live, attenuated and killed pathogens; macromolecular vaccination with reference to subunit vaccine; recombinant and DNA vaccine.
5. Immunoassays: Basic concepts of IP, ELISA, RIA, Immunoblotting, Immunofluorescence, Hybridoma technique for monoclonal antibody production, FACS
6. Neuroimmunology

Practicals based on theoretical syllabus.

BIOS 0602A (Plant biotechnology and plant breeding)

1. **Plant breeding:** Maintenance and conservation of germplasm, Cryopreservation, Mass selection and Pure line selection, Heterosis and hybrid seed production, Male sterility, types and its use in plant breeding. Polyploidy breeding-types of polyploids, origin and effects of auto and

allopolyploids in plants; application of auto and allopolyploids in plant breeding; limitations. Mutation breeding- types: chemical mutagens, radiation, transposons; handling and release of mutagenic varieties.

2. **Plant Tissue culture:** Culture media; composition, preparation and sterilization – Totipotency: definition and importance - Dedifferentiation and redifferentiation - Callus and suspension culture, meristem culture - Somaclonal variation - Somatic embryogenesis , Synthetic seeds -Anther culture and production of haploids - protoplast culture – somatic hybrids –cybrids
3. **Emergence of Biotechnology- Recombinant DNA and Molecular cloning:** Restriction Endonucleases- Ligases and other DNA modifying enzymes (cutting, modifying and joining DNA molecules)
4. **Cloning vectors:** Plasmids-Bacteriophages-Hybrid Vectors-Binary and shuttle vectors; PBR322, PUC, λphage. Ti and Ri Plasmids. Construction of recombinant DNA methods.
5. **Polymerase chain reaction:** methodology-essential features-application
6. **Getting DNA into cells:** Vector method *Agrobacterium* mediated gene transfer-Direct DNA uptake-Electroporation-shot gun method-microinjection
7. **Strategies of molecular cloning:** Screening, selection and analysis of recombinants, Molecular probes- Colony Hybridisation- insitu hybridization-Southern, Northern, Western blotting- RFLP-RAPD, -FISH- DNA and RNA Fingerprinting- Genomic Library- cDNA Library and Gene bank-Brief account of: Antisense RNA technology; Gene Silencing; RNA interference; Microarray and Biosensors
8. **Genomes:** Genomes can be mapped both genetically and physically- Genome sequencing produces the ultimate physical map- DNA Sequencing method- Human Genome Project and plant genome project.
9. **Applications of Biotechnology:**
    i) **Biotechnology of photosynthesis-** Chloroplast genome organization- Gene content and arrangement- regulation of gene expression. Regulation of gene expression in the nuclear coded gene and plastid gene-improvement of photosynthesis.
    ii) **Gene transfer technique for the improvement of agronomic characters-** Pest Resistance-Herbicide Resistance- drought resistance- enrichment of storage protein (Mechanism of gene action)- Flower colour, Shape, fruit ripening, colour and flavour- Improvement of the nutritional quality of seeds- post harvest preservation.
    iii) **Recombinant DNA technology and society-** Biotechnology and Bio ethics – an overview of Genetic screening for any predisposition symptoms, Gene therapy- DNA fingerprinting-GMOs, food safety- environmental concerns- Slow ripening fruits- controlled ripening. Cotton without insecticide- Biosafety issues and GMOs- Genetic screening and privacy- Role of multi national companies – Agribusiness- Golden Rice- (with vitamin-C) Terminator Genes. Economic, and Legal issues. Bio Ethics- Patenting Life forms- Biotechnology, Patents and the Third World. Biotechnology and the future of Agriculture- Stem cell research- sociopolitical issues. HGP and ethical questions.
    iv) **Nano biotechnology-** Basics of Nanobiotechnology: Introduction- Background and definition of nanotechnology - nanosystems in nature- nanoscaled bio molecules (nucleic acids and proteins) –chemical synthesis of artificial nanostructures.-Technologies for visualization of biological structures at the Nanoscale- Atomic force microscope- magnetic resonance force microscopy- Nanoscale scanning electron microscope- Nanoparticles - Applications of nanotechnology in life sciences- Nano biotechnology and systems biology- nanobiology and the cell- biosensing of cellular responses.

Practicals based on theoretical syllabus.

BIOS 0602B (Biophysical methods)

1. **Biophysics–an introduction**: Chemical principles in Biology (thermodynamics, intermolecular forces); Macro-molecular structures; Biological reactions and interactions - functional aspects of various bio-molecules particularly ion channels and motor proteins;
2. **Methods of enzyme purification and characterization** : dialysis, ultra-filtration, ultracentrifugation, molecular exclusion chromatography, isoelectric precipitation, salting in, salting out, solvent fractionation, electrophoresis- paper and SDS-PAGE, ion exchange chromatography, adsorption chromatography, affinity chromatography. Basic concepts of proteomics and enzyme identification.
3. **Spectroscopy, microscopy and structural biology**: Introducing basic principles with applications.

Practicals based on theoretical syllabus.

BIOS0602C (Social physiology, stress physiology, ergonomics and sports physiology)

1. **Social physiology:** Population problem – principles and methods of family planning. Problem of infertility, IVF. Malnutrition – PCM, marasmus, kwashiorkor, marasmic kwashiorkor. Endemic goiter, nutritional anemias, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Implications of Diabetes, CHD**.** Principles and social importance of immunization against diseases. Epidemiology and prevention of cholera, malaria, polio, tetanus, leprosy, tuberculosis, typhoid, hepatitis and AIDS.
2. **Work, Exercise and Sports Physiology:** Concept of work. Physical work—its definition and nature. Power and capacity relation, Classification of work load. Exercise inducing equipment – Aerobic and anaerobic power—concept, factors affecting, methods of measurement and significance of maximal oxygen consumption and excess post exercise oxygen consumption. Energetics of exercise – Short-term and long term, Mechanism of Fatigue and recovery. Concept of endurance, strength and speed in sports activities. Principles of training and detraining. Brief general idea about nutritional aspects of sports, Idea on doping. Lactate threshold, lactate tolerance and their usefulness. Concept of physical fitness and its assessment by Harvard and modified Harvard Step Tests.
3. **Stress Biology:** Concept of Stress, Stressors and Stress response. Idea of Internal and external stressors. Principles of acclimatization and adaptation. Effects of exposure to hot and cold environment. Acclimatization to hot and cold environment. Heat disorders and its preventive measures. Effects of hypobaric and hyperbaric environment. Caisson's disease. Preventive measure for hypobaric and hyperbaric effects. Acclimatization to high altitudes. G forces. Stress and Aging

Practicals based on theoretical syllabus.

BIOS 0602D (Animal Histology, Animal development and Economic Zoology)

Group – A (Animal Histology)

1. Histology of mammalian stomach, liver, kidney, thyroid, pancreas and gonads
2. Ultrastructure of sarcomere and neurone
3. Fixation - Non-additive and additive fixatives and their mode of actions
4. Histological dyes – physical and chemical classification of dyes, mordanting, metachromasia
5. Animal histochemistry – Gomori's reaction, Saccaguchi's reaction, PAS reaction and Faulgean reaction

Group – B (Animal Development)

1. Spermatogenesis and oogenesis in animals

2. General account of cleavage and fate map in animals
3. Morphogenetic movements and gastrulation in chick
4. Organogenesis – development of vertebrate heart, brain, eye and kidney in chick
5. Extra embryonic membrane in chick
6. Placentation in rabbit

Group – C (Applied Zoology)

1. Prawn, Pearl culture.
2. Induced breeding and hybridization techniques in Fish, Composite fish culture and capture.
3. Industrial Entomology – sericulture, apiculture and lac culture
4. Pest biology – bionomics and control of jute, brinjal and sugarcane pests
5. Strategies of Integrated pest management
6. Poultry farming and management
7. Concept of dairy technology with reference to cryopreservation and in vitro fertilization technique.

Practicals based on theoretical syllabus.

BIOS 0603A (Pathophysiology of common human diseases and pharmacological drug design)

1. **Pathophysiology of common Human Diseases:** Discussion of common diseases such as Cancer, Diabetes, artherosclerosis and heart disease, Malaria, Dengue.
2. **Xenobiotics and antioxidants:** Definition and classification of Xenobiotics.Brief outline of xenobiotic metabolism (no detail).Examples of xenobiotics – free radicals and antioxidants.
3. **Pharmacology:** Basic concept of pharmacology. Pharmacokinetics: Drug-receptor interaction, Desensitization of receptors, Absorption, Distribution, Elimination, Half-life. Definition of drug, agonist and antagonist partial agonist and antagonist, Receptors- drug interaction, Spare receptors. Pharmacodynamics: dose-response curves. Beneficial versus toxic effects of drugs**.** Drug biotransformation. Bioavailability. Drug accumulation. Therapeutic index. Cholinergic system, Cholinomimetic and suppressive agents. Neuromuscular blockers, Organ system effects and mechanism of action of adrenoceptor agonists and antagonists: a and ß adrenergic stimulants and blockers. Anti anginal drugs calcium-channel blocker Anesthetics: types and mechanism of action of general anesthetics. Sedatives, Diuretics and Analgesics. Target specific drug and its delivery, Basic concept of forensic toxicology.

Practicals based on theoretical syllabus.

BIOS 0603B (Fundamentals of Genetics)

1. **Sex determination and Sex linkage**: Sex determination patterns in animals and flowering plants; Dosage Compensation; Pedigree analysis: Symbols used; Pedigrees of sex-linked and autosomal traits and patterns of inheritance.
2. **Mobile Genetic Elements**: Insertion sequences; Transposons; Conservative and replicative methods of transposition; P element in Drosophila ; Influence of mobile genetic elements on gene function.
3. **Extranuclear Inheritance**: Comparison between nuclear and extranuclear genetic systems; Extranuclear inheritance by mitochondrial and chloroplast genes; Maternal effect in Lymnaea and Drosophila; Kappa particles in Paramoecium.
4. **Human Genetics** : Chromosome groups in man ; Molecular genetics of Sickle cell anaemia, Cystic fibrosis, Duchenne muscular dystrophy and Huntington disease; Turner's syndrome; Klinefelter's

syndrome; Down's syndrome; Polygenic inheritance of skin colour, Human karyotype; Banding techniques; Use of human cytogenetics in medical science.

5. **Epigenetics:** Basic concepts, genomic imprinting, position effect.

Practicals based on theoretical syllabus.

PG SEMESTER -1

BIOS 0701 (Theoretical)

Methods and Experimental Design [50 marks; 4 credits]

1. Molecular biology and recombinant DNA methods: Isolation and purification of various RNA, DNA and proteins; different separation methods and principles of nucleic acids and proteins by gel electrophoresis; isoelectric focusing; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.
2. Expression of recombinant proteins using bacterial, animal and plant vectors; different PCR methods or isolation of specific DNA sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques; gene knock out in bacterial and eukaryotic organisms.
3. Protein sequencing methods, detection of post translational modification of proteins; DNA sequencing and strategies for genomic sequencing, methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.
4. Histochemical and inmunocytochemical techniques: Antibody generation, detection of molecules using ELISA, RIA, Western Blot, immunoprecipitation, flow Cytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.
5. Methods for structural analysis of biomolecules using UV-visible, fluorescence, circular dichroism, and NMR spectroscopy. Structure determination of biomolecules using X-ray crystallography.
6. Overview of testing of hypothesis, errors of inference and distribution types.Distribution-free test - Chi-square test, G-test.Product moment Correlation- assumptions, properties, computations and applications, Spearman's rank correlation coefficient, Point biserial r, Biserial r, contingency coefficient. Properties and computations of simple linear regression.
7. Radiolabeling techniques- Properties of different types of radioisotopes Normally used in biology, their detection and measurement, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
8. Microscopic techniques- Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM, image processing methods in microscopy.
9. Electrophysiological methods- Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulant of brain, pharmacological testing PET, MRI fMRI, CAT.
10. Methods in field biology- Methods of estimating population density, ranging patterns through direct, indirect and remote observations, sampling method in the study of behavior, habitat, characterization ground and remote sensing methods.

BIOS 0702 (Theoretical) [50 marks; 4 credits]

Part 1- Advanced Cellular Biology [25 marks]

1. Experimental approaches to study cellular organization and processes: Use of pulse-chase experiments, mutants- temperature-sensitive mutants, yeast genetic mutants, dominant-negative mutants, immunoprecipitation and protein-protein interaction studies, use of drugs/ toxins/inhibitors, siRNA mediated knockdown of key proteins, Post-translational modifications and

how to test for them.Regulation of cellular activities, quality control (autophagy, degradative pathways).

2. Cell Wall, Extracellular matrix and Cell interaction - Cell –cell interaction; Cell matrix interaction.
3. Cell communication – Signaling molecules; Receptors: G- protein coupled receptor, Receptor Tyrosine Kinase, Cytokine receptors; Pathways of Intracellular Signal Transduction
4. Cytoskeleton - Microfilaments; Microtubules; Intermediate filaments; Molecular motors.
5. Nuclear Transport –Import and Export of protein; Export of different RNAs
6. Eukaryotic Cell Cycle - Cyclin and Cyclin-dependent Kinase; Molecular mechanisms of Checkpoint regulation.
7. Stem cells and differentiation
8. Apoptosis – Caspase; Pathways of Apoptosis; Distinctive features in insects , nematodes and mammals .
9. Cancer – Phenotypic characters of cancer cells ; Genetic basis of cancers : Protooncogene , Oncogene , Tumor suppressor genes ; Oncogenesis ;Cancer Immunotherapy

Part 2- Developmental Biology [10 marks]

1. Basic concept of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; role of reference organisms in developmental processes
2. Cell fate and cell lineages, stem cell-types, genesis and differentiation in both animals and plants
3. Molecular biology of stem cell and its regulatory molecules, emerging trend and clinical applications;
4. Germ cells, nuclear programming and gene networks
5. Genomic equivalence and the cytoplasmic determinants;
6. Axis determination in plant and animal, non-coding RNA s in development, non-cell autonomous signaling in plant development
7. Imprinting; mutants and transgenics in analysis of development.
8. Gametogenesis and fertilization
9. Morphogenesis and organogenesis
   i) Animals - cell aggregation and differentiation, patterning and shaping of the early embryo, limb development and regeneration, neurogenesis, environmental regulation of normal development, sex determination.
   ii) Flower development, floral and inflorescence meristems, different physical and physiological factors including flower induction, ABC model and beyond. Genetics of flower development in monocotyledonous flowers, floral asymmetry and gametogenesis

Part 3-- [15 marks] Fundamentals of Neurobiology

1. Introduction to neurons, glia and muscle.
2. Membrane Potentials:
3. Ion Channels, Ion Pumps and receptors:
4. Drugs and toxins as tools in neuroscience research.
5. Muscle Contraction and neuromuscular transmission, mechanism of muscle contraction
6. Synapse and synaptic transmission
7. Brief idea of sensory physiology
8. Diseases of Nervous System: Neurobiology of affective disorders or mood disorders; dopamine and addiction; current research on Alzheimer's disease, Parkinson's disease, Huntington's disease, autism

spectrum disorders (ASD) and Japanese encephalitis, Multiple sclerosis as a disease of demyelination.

9. Methods in Neurobiology: Single neuron recording, intracellular recording, extracellular recording, ECG, EEG, lesion and stimulation of brain, MRI, fMRI, PET, CAT, Morris water maze assay.

BIOS 0703 (Theoretical) [50 marks; 4 credits]

Part 1- Advanced Biochemistry [25 marks]

1. **Enzymology and enzyme technology**:
   i) Enzyme regulation- allosteric enzyme, definition and example, allosteric modulators, feedback inhibition, kinetic properties of allosteric enzyme, Hill and Scatchard plots, regulation by covalent modification (like phosphorylation), regulation by proteolytic cleavage of protein, zymogens with example
   ii) Multienzyme system - Occurrence, isolation and their properties: Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthase complexes. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase.
   iii) Enzyme technology - Large-scale production of enzymes, enzyme reactors, immobilization of enzymes by chemical and physical methods, effect of partition of kinetics and on changes in pH and hydrophobicity. Industrial and clinical applications of enzyme.
2. **Overview of protein-ligand interaction and their analyses.**
3. **Metabolic diseases**
   i) Intermediary metabolism
   ii) Disorders of Carbohydrate Metabolism - Diabetes mellitus, glucose and galactose tolerance tests, sugar levels in blood, renal threshold for glucose, factors influencing blood glucose level, glycogen storage diseases, pentosuria, galactosemia.
   iii) Disorders of Lipids - Plasma lipoproteins, cholesterol, triglycerides and phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Gaucher's disease, Tay-Sach's and Niemann- Pick disease, ketone bodies, Abeta lipoproteinemia.
   iv) Inborn Errors of Metabolism - Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia.
   v) Abnormalities in Nitrogen Metabolism - Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance.
4. **Plant Biochemistry**
   i) Photosynthesis - Light harvesting complexes; mechanisms of electron transport;
   ii) photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways.
   iii) Nitrogen metabolism - Nitrate and ammonium assimilation.
   iv) Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.
   v) Stress metabolism in plants - Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism, criteria of stress tolerance.
5. **Microbial Biochemistry**
   i) Bacterial cell membrane - structural diversity including Archaea.
   ii) Membrane transport in prokaryotes- group transport, binding protein transport.
   iii) Fermentation- lactic acid, ethanolic, propionic acid, butanediol, mixed acids, amino acid.
   iv) Biosynthesis - peptidoglycan, lipopolysaccharide, poly-p-hydroxybutyric acid.

v) Microbial photosynthesis (photoautotrophy)- light absorption, difference in photosynthetic pigments, oxygenic and anoxygenic photosynthesis.
vi) Alternative bacterial biochemical pathways- Entner Doudoroff pathway, methylglyoxal pathway, reductive TCA cycle, hydroxypropionate pathway.
vii) Assimilation of organic C1 compounds - methanotrophy, methylotrophy.

Part 2- Advanced Molecular Biology [25 marks]

1. **Genome organization**: Organization of genomes in prokaryotes and eukaryotes, Chromatin organization and packaging; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation, Telomeres and telomerase, DNA topology, Knots and links, Linking number, Writhing and twisting, DNA supercoiling, Topoisomers, Role of DNA topology in replication and transcription. DNA Topoisomerases in prokaryotes and eukaryotes.
2. **DNA Replication, recombination, damage and repair**: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, Homologous and non-homologous recombination, site specific recombination, Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination, different kinds of DNA damage, DNA repair mechanisms in prokaryotes and eukaryotes, Diseases due to failure of DNA repair.
3. **RNA synthesis and processing**: RNA world and RNA replication; Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, RNA transport (Emphasis on eukaryotic machinery).
4. **Protein synthesis and processing**: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins (Emphasis on eukaryotic machinery).
5. **Molecular evolution**: Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence, Speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution

BIOS 0791 (Practical corresponding to BIOS 0702) [50 marks; 4 credits]
BIOS 0792 (Practical corresponding to BIOS 0703) [50 marks; 4 credits]

PG SEMESTER – 2

BIOS 0801 (Theoretical) [50 marks; 4 credits]

Part 1- Advanced Microbiology [25 marks]

1. **Life cycle:** Entry, replication and egress of DNA and RNA viruses.
2. **Phage genetics**: Lytic and lysogenic cycles of bacteriophage; Virulent and Temperate phage, Prophage; Study of plaque morphology; mapping of phage chromosome by phage crosses.
3. **Transfer of genetic material and recombination in bacteria**: molecular aspects of transformation, conjugation, transduction. Chromosome mapping by interrupted mating experiment.
4. **Bacterial photosynthesis, biogeochemical cycling of sulfur and nitrogen** (with special emphasis on nitrogen assimilation by free living and symbiotic bacteria and nif genes).

5. **Host pathogen interaction**: mechanism of microbial pathogenesis (bacteria and virus), genetics of pathogenicity and virulence.
6. **Antimicrobials**: types and mode of action.
7. **Bioremediation**: use of microbes for treating pollutants (hydrocarbons, oils, heavy metals).
8. **Microbes in commerce**: source, production process and uses of - vaccines (attenuated and live virus), antibiotics, biopolymers, biosensors, biopesticides and biofuels.
9. **Use of microbes in genetic engineering**.

Part 2- Immunology [25 marks]

1. **Introduction to Cellular and Molecular immunology**: Innate immune response, adaptive immune response, B and T cell activation, Complement pathway, Vaccine strategies.
2. **Advanced Immunological techniques:** FACS, Immunofluorescence, Immunoblotting, ELISA
3. **Transplantation Immunology**: Distribution, structure, function and genetic control of MHC, glycoproteins; HLA typing; Mechanisms of graft rejection; Basic concept of bone marrow transplantation; Foetus as an allograft and survival of foetus against maternal graft rejection mechanisms.
4. **Tumor Immunobiology**: Evasive mechanisms of tumor cells; Tumor specific antigens; Immunosuppression in tumor microenvironments; Immunotherapy of cancer using monoclonal antibody and cytokines; NK cells and dendritic cell therapy of cancer; Vaccine against human cervix cancer.
5. **Immune deficiency disorders**: Concept of primary immune deficiency with reference to Di George syndrome, agammaglobuninemia and SCID; etiology, symptoms and treatment of AIDS.

BIOS 0802 (Theoretical) [50 marks; 4 credits]

Part 1-Advanced Genetics [30 marks]

1. **Model systems in genetic analysis**: *E. coli*, *Neurospora crassa*, yeast, *Arabidopsis*, Maize, *Drosophila*, *C. elegans*, Zebra fish.
2. **Quantitative Genetics**: Multilocus control; QTL analysis; Quantitative inheritance in plants and human.
3. **Population Genetics:** Hardy- Weinberg equilibrium and assumptions; Extension to Multiple allele and Sex-linked allele; Variables of Hardy – Weinberg equilibrium – Mutation, Migration, Small population size, Natural selection.
4. **Molecular basis of recombination**: Double strand break- repair model; Rec BCD pathway in E. coli; Homologous recombination in eukaryotes; Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion.
5. **Regulation of Gene expression:** Operon in bacteria; Regulation in eukaryotes: Gene rearrangement (Ig gene ; Yeast mating type; Trypanosome VSG gene); Chromatin remodeling.
6. **DNA repair**: Excision repair; Mismatch repair; Recombination repair; NHEJ; Translesion DNA synthesis
7. **Epigenetics**: Genomic imprinting; Histone code; Epigenomics.

Part 2- Environmental Science [20 marks]

1. **Basic concept of ecology and environment**
2. **Conservation**: In situ conservation: sanctuaries, biosphere reserves, national parks, nature reserves, preservation plots. Ex situ conservation: botanical gardens, zoos, aquaria, homestead garden, herbarium.

3. **Environmental pollutants and pollution**: classification of pollutants and mechanism of action; source, effects and control measures of pollution- (Air, Water, Noise and Radiation)
4. **Environmental toxicity**: Concept of acute and chronic toxicity; Concept of dose response relationship (LDso, LCso, TL V); roots of entry of toxicants- mechanism and resistance; Bioassay methods; concepts of biomagnifications and bioaccumulation, source of heavy metals and its mechanism of action; uptake of toxic substances by plants and animals- detoxification and excretion of toxic substances.
5. **Health and environment**: occupational hazards and associated diseases, silicosis, anthrax and other lung diseases; WHO standards of working conditions; physical factors affecting occupational health (heat, cold and temperature); prevention of occupational diseases.
6. **Global environmental changes and major drivers of biodiversity changes**: climate changes, global warming - causes and consequences.
7. **Environmental impact assessment**: Environmental impact assessment (EIA) general guide lines for preparation of environmental impact statement (EIS), international organization for standardization (ISO), ISO 14000 standards and certification, environmental clearance for establishing industry.
8. **Environmental biotechnology**: concept and broad outlines of various aspects of biotechnology- waste treatment, biofuel production, biofertilizer, concepts of integrated pest management and biopesticides.

BIOS 0803 (Theoretical) [50 marks; 4 credits]

Part 1- Research conduct and Bioethics [20 marks]

1. Introduction, Overview, and Research Misconduct, rules and regulations in India.
2. Data Management
3. Mentoring, mentor-mentee responsibilities
4. Authorship Guidelines, Publication and Peer Review
5. Intellectual property, plagiarism, patents
6. Collaboration
7. Reporting and representing research, representing images.
8. Bias, Conflicts of Interest
9. Ethical use of animal subjects
10. Protection of Human subjects
11. Stem Cells
12. The Ethics of Plant Use, transgenic crops
13. Agricultural Ethics
14. Ecosourcing-code of practice
15. Radioactive, chemical and biohazard safety, waste management and disposal
16. Social Responsibility and Whistleblowing

Part 2- Emerging field of science [30 marks]

1. **Nanotechnology**: Elementary concept of nanotechnology and its applications; cellular nanomachines; bio-inspired nanomaterials for a new generation of medicine; nanoscience in medicine, delivery system, and vaccine; nanoparticles in medical detection and diagnostics; synthesis of anyone inorganic or organic nanoparticles, characterization, and applications.

2. **Synthetic Biology**: Basic concepts of synthetic biology; concepts of synthetic genome, organelles, and minimal cell; metabolic engineering; bacterial drug factories; synthetic biology in clinic, and biosensor.
3. **Systems Biology**: Ttranscriptomics, proteomics, metabolomics, lipidomics, glycomics, and phosphoproteomics. High-throughput screening and sequencing {next-Gen}.
4. **Quantitative Biology including various advanced PCR**.
5. **Personal Genomics. Computational biology. Structural biology and modeling ecology**.

BIOS 0891 (Practical corresponding to BIOS 0801) [50 marks; 4 credits]
BIOS 0892 (Practical corresponding to BIOS 0802) [50 marks; 4 credits]

PG SEMESTER 3

BIOS 0901A (Animal structure and function)

Group – A (Non-chordates)

1. Coelom and its evolution.
2. Nutrition biology with reference to insects, mollusks and echinoderms.
3. Blood, respiratory pigments and organs, gaseous exchange with reference to arthropoda and mollusca.
4. Excretory organ and physiology of excretion with reference to annelida and arthropoda.
5. Reproductive biology of major invertebrate groups.
6. Endocrine glands and chemical messengers in invertebrates.
7. Sense organs in invertebrates.

Group – B (Chordates)

1. Protochordate biology - current knowledge of notochord microanatomy, tail resorption in Ascidia and endostyle function.
2. Integumentary glands and their derivatives in vertebrates.
3. Anatomical plan and functional significance of different types of jaw suspension in vertebrates.
4. Comparative anatomy and evolution of portal system in vertebrates.
5. Respiratory biology with reference to aquatic and aerial life.
6. Functional areas of vertebrate brain.
7. Receptors organs in vertebrates.

Practicals based on theoretical syllabus.

BIOS 0901B (Molecular biology and biochemistry of diseases)

1. **Cancer Biology**: oncogenes, tumor suppressor genes, micro RNAs in cancer, Chromosomal rearrangements and cancer, Viruses and cancer, Chemical carcinogenesis, Cell Cycle Control, G1 and "Go" Signals, Stop Signals, Cell Cycle in Stem Cells, Growth factors and Cancer Signaling, Metastasis, Angiogenesis, Tumor microenvironments and Stroma, Inflammation and Cancer, Therapeutic strategies.
2. **Infectious diseases:** Molecular mechanisms for Host-pathogen interaction**,** Disease models: Cholera, Tuberculosis, Malaria, Influenza, HIV and AIDS, Prion protein diseases.
3. **Neuropathological disorders:** Molecular pathways to neurodegeneration: β-amyloid, Tau, α-Synuclein, misfolding and aggregation of disease proteins, mitochondrial dysfunction, gene-

environment interactions in neurodegenerative disease, Parkinson, Alzheimer, Huntington's disease, Creutzfeldt-Jakob disease.

4. **Genetic diseases:** Loss of function mutations, Gain of function mutations, Molecular pathology: from gene to disease, from disease to gene, of chromosomal disorders, molecular basis for Hemophilia, Colour blindness, Sickle cell anemia, Thalassemia, Xeroderma pigmentosum, Cystic fibrosis, Duchenne muscular dystrophy, SLE, Myasthenia gravis.
5. **Molecular mechanisms of metabolic and nutritional diseases:** inborn errors of metabolism, diseases related to vitamins and minerals, obesity.

Practicals based on theoretical syllabus.

BIOS 0901C (Alimentary, Neuromuscular, Cardiovascular Physiology and Biostatistics)

Gastro-intestinal Physiology and its disorders

1. Control of Gastro-intestinal functions
2. Immune function of G.I. tract
3. Assessment of gastric, pancreatic and intestinal functions in different pathophysiological conditions including its different diagnostic techniques; liver function tests and their significance

Molecular Neurobiology

1. Physiology of Muscular Dystrophy, Myasthenia gravis, bell's palsy
2. Nerve-muscle physiology: cellular and molecular mechanism of action
3. Recent advances in our understanding of brain disorders
4. Cerebral attack: impairment and recovery of higher brain functions

Physiology of Heart and its Diseases

1. Cardiac remodelling; regenerative capacity of heart
2. Angiogenesis: interaction between endothelium and smooth muscle spring Molecules; role of signalling molecules in cardiovascular system
3. Maintenance of vascular tone: role of ion channels
4. Obesity - -linked cardiovascular pathology
5. Stem cell modification of vascular function
6. Cardio-vascular Physiology
   - Cardiac metabolism and energetics
   - Electrocardiogram
   - Arrhythmias
   - Cardiac work
   - Heart Transplantation/ artificial Heart

Biostatistics

1. Nonparametric statistics: G test for goodness of fit, Mann-Whitney U test, Wilcoxon's signed rank test, median test. Odd Ratio test
2. Analysis Variances: Models and types of ANOVA, one way ANOVA – assumptions computation and interpretation of variance ratio, multiple comparison t tests, Scheffe's F- test and Gabriel's SS-STP; Kruskal-Wallis non-parametric ANNOVA, Two way ANOVA without replication
3. Application of Statistical principles in physiological problems

Practicals based on theoretical syllabus

BIOS 0901D (Plant systematic; Plant anatomy and pharmacognosy)

Plant systematic:

1. **Define the terms**: Taxonomy, Systematics and Molecular Systematics, e-Flora, Character and character-state, Angiosperm Phylogeny Group (APG), Monophyly, Paraphyly, Polyphyly, clade, lineage, Cladistics, Phentic, Plesiomorphy, Synapomorphy, Homology and Homoplasy, Principles of Parsimony, Epitype, Isonym, Homonym, Synonym.
2. **Concept of ICBN and ICN:** salient features of Melbourne-ICN (2012); brief knowledge of nomenclatural types as per Melbourne-ICN (2012).
3. **Numerical Taxonomy:** Aims and objectives, characters and attributes, OTUs. Coding cluster analyses, merits and demerits.
4. **Recent Plant Classification:** APG-System (Angiosperm Phylogeny Group); broad outline of APG-III (2009) including its merits and demerits.
5. **Chemotaxonomy:** Role of phytochemicals (especially secondary metabolites) in plant taxonomy.
6. **Molecular approaches to plant taxonomy:** Application of DNA markers in angiosperm taxonomy; molecular phylogeny.
7. **Salient features, Floral range and phylogenetic importance of the following families**:

Dicots- Annonaceae, Papilionaceae, Lamiaceae, Nepenthaceae, Rubiaceae, Asteraceae
Monocots- Alismaceae, Zingiberaceae, Orchidaceae, Poaceae

8. **DNA bar-coding** for identification of plants.

Plant anatomy and pharmacognosy:

Group A: Plant anatomy

1. **Cell wall and development:** Chemistry of Cell wall- cellulose, hemicellulose, and polysaccharides. Organization of primary cell wall. Secondary wall chemical constituents- lignins, suberin, callose; Organization of secondary wall.
2. **Nodal patterns**: Evolutionary aspect-unilacunar, trilacunar, multilacunar. Leaf trace and branch trace.
3. **Cambium:** Development of vascular cambium and cork cambium.
4. **Wood Anatomy:** Physical and mechanical properties of wood. Phloem structure, xylem structure, xylem evolution.
5. **Applied Plant Anatomy.** – Application in Bio-medics, Forensic science, Climatology.

Group B: Pharmacognosy

1. Origin of secondary metabolites, important types (Alkaloids, Glycosides, Glucosinolate compounds, Volatile oil, Resins), source, properties and examples.
2. Brief account of Acetate Malonate, Acetate Mevalonate and Shikimate pathways, Turnover and degradation of secondary metabolites.
3. Methods of extraction, isolation and characterization of secondary metabolites. Plants as source of drugs, pharmacological action and quality control.
4. Non-medicinal toxic plants: Hallucinogenic, allergenic, teratogenic and other toxic plants.

Practicals based on theoretical syllabus.

BIOS 0901E (Palaeobotany and palynology; Plant pathology)

Palaeobotany and palynology:

1. Sedimentary rocks; Taphonomy; Dating of fossils- isotopic and non-isotopic, dendrochronology, rhythmic bands and molecular clock; nomenclature and reconstruction of fossil

plants: different methods with examples; Stratigraphy; Basic concepts of continental drift and plate tectonics.

2. Palaeobotany in relation to biosphere, geological time scale, geosphere and atmosphere, Origin of life; first prokaryotes; evolution of eukaryotes; geological records of algae, fungi, bryophytes and enigmatic fossils and their evolutionary and ecological significance.

3. Origin and evolution of land plants- different evidences, biogeographical distribution of early land plants (Silurian- early Carboniferous), earliest trees in the fossil record. Permo-Carboniferous floral provinces with climatic condition and endemic genera. Progymnosperms-classification, origin and evolution, of stele.

4. Preovules, hydrasperman reproduction; evolution of closed carpel; heterospory and seed habit

5. Origin of angiosperms, concept of palaeoherbs and eudicots, cladistic and molecular biological approaches to trace phylogeny of angiosperms

6. Pollen Morphology: Sporoderm stratification: Aperture and aperture types; Harmomegathic adaptation; Exine ornamentations.

7. Applied Palaeobotany and Palynology:

i) Ancient DNA study from angiosperm plant compression, coal and petroleum exploration.
ii) Palaeopalynology and hydrocarbon exploration; Melissopalynology, Quaternary Palynology; Neopalynology, palaeofloristics, palaeogeography, palaeoecology and palaeoclimatology
iii) Aerobiology: General Introduction; Pollen Allergy: Concept of pollen allergy (Type-I); Air sampling methods (volumetric only); Diagnosis of allergy (Skin Prick test and ELISA); treatment of pollen allergy.

Plant Pathology

1. Host- pathogen interactions - Necrotrophic and biotrophic pathogen induced diseases; Mechanisms and site of actions of enzymes, toxins, growth regulators and other biochemical pathogenic weapons involved in disease development; Physiological and molecular changes in pathogens during

2. Host defense and Resistance - Types and systems of host defense in plant kingdom; Genetic, molecular and biochemical basis of host defense against pathogens:

i) Hypersensitive reaction - mechanism and biomolecules involved;
ii) Pathogenesis Related proteins
iii) Genetics of virulence in pathogens and resistance in hosts

3. Resistance - Local Acquired (LAR), Systemic Acquired (SAR), Induced Systemic (ISR)

4. Plant immunization against pathogens. Defense through Plantibodies.

5. Plant Disease Management - Principles and methods of plant disease control, Modern biotechnological approaches for imparting host resistance to pathogens, disease forecasting.

6. Application of molecular biology to plant disease control - transgenic approach for crop protection, genetic and biochemical manipulations of hosts for imparting resistance to pathogens, engineering chemicals that elicit defense response to plants.

Practicals based on theoretical syllabus.

BIOS 0902A (Animal taxonomy, ecology, evolution and behaviour)

Group – A (Animal taxonomy)

1. Principles of phenetics and cladistics
2. Character states and character state transition.
3. Difficulties of universal application of biological species concept.

4. Modes of speciation – allopatry, sympatry and parapatry.
5. Concept of cytotaxonomy and molecular taxonomy.

Group – B (Animal ecology)

1. Population regulation.
2. Life table, survivorship curve, metapopulation concept.
3. Acidification – cause and consequence
4. Eutrophication of water bodies and its impact.
5. Wetland ecology with special reference to West Bengal.
6. Ecology of marine biota.

Group – C (Evolution)

1. Population as evolutionary unit with reference to Hardy-Weinberg law and factors affecting Hardy-Weinberg equilibrium.
2. Evolution and tinkering.
3. Punctuated equilibrium hypothesis.
4. Concept of molecular clock and molecular drive.
5. Evolutionary origin of tetrapods, birds and mammals.

Group – D (Animal behavior)

1. Foraging behavior of animals with reference to cost and benefit analysis.
2. Aggressive behavior – competition, territoriality and dominance hierarchy; Game theory and evolutionary stable strategy.
3. Nervous control of behavior with reference to hypothalamus, hippocampus and amygdale.
4. Hormonal and genetic control of behavior with reference to role of androgen, prolactin, fixed action pattern and imprinting of behavior.

Practicals based on theoretical syllabus.

BIOS 0902B (Current trends and advances in cell and molecular biology)

1. **Historical perspective**: Discussion on the landmark discoveries in the field of Molecular Biology, Cell Biology and Genetics.
2. **Gene therapy** - Vectors for somatic cell gene therapy, Enhancement in genetic engineering, Gene therapy for inherited immunodeficiency syndromes, Cystic fibrosis gene therapy, HIV-1 gene therapy. Retroviral mediated gene transfer.
3. **Stem cells and translational medicine** - Embryonic stem cells and therapeutic cloning, multi-potent adult stem cells, pluripotent adult stem cells, transgenic stem cells, Regeneration therapy.
4. **Molecular technologies** – an overview of Genetic screening for any predisposition symptoms, Cancer screening, molecular markers and molecular profiling, DNA fingerprinting (Paternity and Forensics), cloning, *in vitro* fertilization, transgenic organisms, xenotransplantation, GMOs.
5. **Modern Biology approaches**:Techniques for Mapping genomes, Genome sequencing projects, Chromosome walking, shot gun sequencing, Structural and Functional Genomics, Genetic switches and oscillators

Practicals based on theoretical syllabus.

BIOS 0902C (Applications of biophysical methods in Biology)

Electromagnetic radiation, Vibrational spectroscopy (IR and Raman); Electron Paramagnetic Resonance spectroscopy; Atomic absorption spectroscopy; Mossbauer spectroscopy; Fluorescence correlation spectroscopy; 3rd generation synchrotron based spectroscopy; Circular Dichroism spectroscopy; Structural Biology research, X-ray protein crystallography and Nuclear Magnetic Resonance spectroscopy; Analytical ultracentrifugation.

Practicals based on theoretical syllabus.

BIOS 0902D (Respiratory, Excretory, Endocrine, Reproductive Systems and Biorhythms)

Respiratory System and its applied aspects

1. Functional anatomy of respiration and spirometry
2. Pulmonary gas exchange and regulation of respiration- neural and chemical
3. Hypoxia, cyanosis, asphyxia, dyspnoea, periodic breathing and sleep apnoea
4. Non-respiratory functions of lung

Kidney

1. Excretory and non-excretory functions
2. Cystometry and higher functions
3. Renal failure, kidney function tests and artificial kidney

Neuroendocrinology and molecular endocrinology:

1. Hypothalamic and and suprahypothalamic control of endocrine functions.
2. Regulation of endocrine functions and their pathophysiology.
3. Bioassay and immunoassay.
4. Receptors and growth factors.

Reproductive physiology

1. Gametogenesis and its molecular control
2. The sperm-egg interaction and nidation: molecular mechanism
3. Sex determination and differentiation
4. Parturition and lactation:
5. Assisted reproductive technology

Biological Rhythms

1. The Circadian Clock: Evolution and adaptive significance
2. Role of SCN in human, photic and non photic pathways, role of melatonin and other neurotransmitters in circadian control
3. Alterations of circadian rhythms: jet lag, work-shift syndrome, delayed and advanced sleep-phase syndrome
4. Affective disorders: SAD and light therapy

Practicals based on theoretical syllabus.

BIOS 0902E (Plant Physiology, crop improvement and molecular plant breeding)

1. Solute transport and photoassimilate translocation – Transport of solutes across membrane barriers, Membrane transport proteins, mechanisms of loading and unloading of photoassimilates, Assimilate allocation and partitioning.
2. Plant hormones –Auxin: Physiological effects of auxin- Cell Elongation, Phototropism and Gravitropism, Developmental effects of Auxin, Auxin signal transduction pathways. Gibberellins- Physiological mechanisms of gibberillin induced growth, Gibberillin signal transduction. Cytokinins-biological role, cellular and molecular modes of action. Ethylene- developmental and physiological effects, cellular and molecular modes of action. Abscisic acid- developmental and

physiological effects, cellular and molecular modes of action, Strigolactone and other plant growth regulators-Physiological role in plant development

3. Plant growth and development- Role of phytochrome and light in plant development, blue light response
4. The control of flowering: Autonomous regulations versus environmental cues, the shoot apex and phase changes, Photoperiodism, Vernalization, Signaling involved in flowering. .
5. Stress biology- Two-phase growth response, Intracellular ion compartmentalization. The oxidative stress paradigm, oxidant and antioxidant signaling in plants, protein oxidation and its regulation, ROS and redox signaling in response of plants to abiotic stress. Perception and transduction of stress signaling (Ca2+, H2O2, NO, ABA, ethylene and Polyamines) – Stress responsive genes.
6. **Molecular Plant Breeding:** Molecular markers: Definition, properties, types of molecular markers, Comparison of different marker systems – Development of mapping population – Marker Assisted Selection (MAS), screening and validation; Mapping genes on specific chromosomes; QTL mapping; Genome wide association mapping (GWAS), Gene pyramiding; Evolution of crop biotechnology from plant breeding to transgenics.
7. **Crop stress and productivity:** General introduction about stress – Abiotic (Osmotic, temperature and Heavy metal stress) and Biotic stress (bacterial, viral, fungal pathogens and herbivores) – Plant physiological and biochemical changes under stress – Perception and transduction of stress signaling (Ca2+, H2O2, NO, ABA, ethylene and Polyamines) – Stress responsive genes and concept of stress tolerant / sensitive germplasms - Integrated Pest Management – Herbicide, weedicide and surfactants.
8. **Genetic engineering for Crop improvement:** Important biotic and abiotic stress genes and their utility in crop improvement: Bacterial resistance, Viral resistance (coat protein mediated, nucleocapsid gene), Fungal resistance (chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins), Insect pests resistance (Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor), nematodes resistance, herbicide resistance, (phosphoinothricin, glyphosate, sulfonyl urea, atrazine), Salinity (SOS, NHX, HKT1), Drought (DREB, ABI), thermal stress (COR, ABI, HSF, HVAPX), flooding (ANPs) and submergence tolerance (Sub1A).
9. **Gene silencing for crop improvement:** Role of antisense and RNAi in crop improvement - regulated and tissue specific expression of transgenes for crop improvement - Terminator gene technology - Transgenic and gene knockout technologies. Targeted gene replacement.

Practicals based on theoretical syllabus.

BIOS 0903A (Animal physiology and Animal development)

Group – A (Animal Physiology)

1. Structure and function of blood in invertebrates and vertebrates.
2. Physiology of hibernation, aestivation and diapause.
3. Stress physiology of animals – Acclimatization in high altitude, General adaptation syndrome.
4. Neuroendocrine function in animals – neuroendocrine integration, neurosecretory cells vs. neurons, neurohaemal organs, neurosecretion in invertebrates and vertebrates.
5. Estrus and menstrual cycle and spermatogenesis in animals and their hormonal regulation
6. Pre-migratory physiological changes in animals.

Group – B (Animal Development)

1. Fertilization with special reference to block polyspermy.

2. Regeneration in animals.
3. Embryonic induction and competence in animals.
4. Natural and artificial parthenogenesis in animals.
5. Axis differentiation in Drosophila and its genetic regulation.
6. Homeotic genes and their significance in animal development.

Practicals based on theoretical syllabus.

BIOS 0903B (Advanced macromolecular structure, function and dynamics)

1. **Architecture of biological macromolecules**: Proteins, RNA and DNA; structural motifs; super-secondary structures; understanding the association of structural motifs of macromolecules with conserved functions in the evolutionary hierarchy

2. **Macromolecular assemblies**: Protein-ligand interaction (e.g. protein/DNA; protein/RNA, protein/small molecules); Membrane proteins: G-proteins-GPCR, Chromatin-nucleosome, ribosome assemblies, secretion systems involved in pathogenesis; methods to study these macromolecular assemblies

3. **Protein folding and dynamics**: Principles of protein folding; Levinthal's paradox; Protein misfolding and aggregation; Chaperone assisted protein folding.

4. **Protein engineering and synthetic biology:** definition, steps involved, applications; Features or characteristics of proteins that can be engineered (definition and Electives methods of study)– affinity and specificity; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc; directed evolution; incorporation of non-natural amino acids in the protein; uses for metabolic engineering; synthetic biology: understanding biological parts and their respective properties; behaviour of basic network motifs in cellular and synthetic systems; structure of biological networks; risk, opportunities, ethical and social challenges associated with synthetic biology.

BIOS 0903C (Medical microbiology)

1. **Introduction to infectious diseases**: bacteria, viruses, fungi, protozoa, helminths and arthropods, and other such as prions.
2. **Host defences**: entry, replication, spread, exit, and transmission; innate and adaptive defences and their action; pathological consequences of infections
3. **Detection and diagnosis**.
4. **Molecular pathogenesis**: control and prevention: epidemiologic consideration, vaccination, antimicrobial agents and therapy of:(I) bacterial diseases, (II) viral diseases , (III) microbes in cancer, (IV) fungal diseases, (V) protozoan diseases, (VI) parasitic diseases, (VII) prion disease
5. **Hospital infection, sterilization, and disinfection**.

Practicals based on theoretical syllabus.

BIOS 0903D (Sports physiology, Man and environment (work, and stress) and sensory physiology)

Sports Physiology

1. Concept of Biological work
2. Evaluation and measurement of work
3. Quantitative evaluation and physiology of static, dynamic and isokinetic work
4. Elements of Biomechanics and low back pain, pain mapping and management
5. Principles of training and sports specific training
6. Sports injury and its management

7. Concept of doping.

Ergonomics and Occupational Management

1. Development of Ergonomics
2. Anthropometry and somatotyping
3. Application of Ergonomics in agriculture and industry

Man- environment and community health

1. The Environment: Physical and biotic; interactions between biotic and abiotic interactions
2. Biology of communicable diseases
3. Stress: physiology, management and acclimatization

Sensory Systems

1. The taste system (molecular basis of transduction and sensory processing
2. olfactory system: transduction-molecular basis, processing of odor information
3. The sense of Balance: the labyrinth structure of hair cells, sensory transduction, central vestibular pathways, vestibular function, weightlessness
4. Hearing receptors, molecular mechanism of signal transduction and frequency discrimination, audiometry, deafness
5. Vision: Retinal circuits and functional cell types, visual signal transduction, central visual pathways
6. Cognitive behaviour of senses

Functions of the Nervous system:

1. Behavioural physiology
2. sleep and the electrical activity of the brain
3. Control of posture and movement
4. The autonomic nervous system: chemical transmission and functions.
5. Concepts of neuroimmunology
6. Emotions, memory, learning and speech

BIOS 0903E (Plant biotechnology and Intellectual Property Rights)

1. **Plant Tissue Culture:** *Methods of sterilization* - medium composition and preparation - MS media - culture initiation and incubation of culture. Callus induction and establishment. Callus sub-culture and maintenance. Cell suspension culture - characteristics. Micropropagation: methods - axillary and adventitious budding - advantages. Somatic embryogenesis - somatic embryo development and synthetic seed production. Somaclonal variation and applications. Androgenesis and gynogenesis. Plant protoplast isolation, culture and fusion - Mechanism of call wall regeneration from protoplasts and application of protoplast hybridization - Biotransformation and immobilization of plant cells - Hairy root clones - Production of secondary metabolic compounds using cell and tissue culture.
2. **Basics tools in Biotechnology:** *Molecular Tools and Their Applications* - Restriction enzymes, Modification enzymes, Ligation of DNA fragments, Nucleic Acid Purification, Yield Analysis, Nucleic Acid Amplification and its Applications - Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, cDNA Synthesis and Cloning - mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening, fundamental *in silico* tools used in plant biotechnology
3. **Genetic modification of plants:**

i) Vectors - Plasmid biology, phage vectors, cosmid and plasmid vectors, artificial chromosome vectors, shuttle vectors and expression vectors - Selection of vectors for copy number - Promoters and Terminators.
ii) Introducing genes into prokaryotes and plants - Natural gene transfer methods, calcium chloride mediated transformation, Transfection with phage vectors.
iii) Methods of introduction of foreign DNA in plant system - *Agrobacterium* mediated, *in planta* method, Virus-mediated, Direct gene transfer through Particle bombardment, protoplasts transformation, Chloroplast transformation and alternative methods. Transgene stability, gene silencing, removal of marker genes. Basics of mitochondrial engineering
iv) Confirmation of transgene integration - Southern, Northern and Western Blotting, Dot and Slot blots and Antisense RNA technology.

4. **Genetic transformation by *Agrobacterium:*** *Agrobacterium*-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T- DNA transfer; Disarming the Ti plasmid, *Agrobacterium*-mediated gene delivery, Cointegrate and binary vectors and their utility; Flower dip transformation; Screenable and selectable markers; Monocot transformation, Promoters and poly A signals. Management of transgenic plants, consumer issues, IPRs.
5. **Basic applications of plant genetic engineering:** Abiotic and biotic stress resistance: Pest Resistance - Herbicide Resistance - drought resistance - enrichment of storage protein - Mechanism of gene action - Flower color, Shape and flavor modifications - Modification of fruit ripening process - Improvement of the nutritional quality of seeds - Post harvest preservation. Metabolomics - Applications of Metabolic Engineering - in pharmaceuticals - Bioenergy generation, Bioethanol and biohydrogen.
6. **Introduction to Intellectual Property and Patents:** Types of IP: Patents, Trademarks, Copyright and Related Rights, Protection of GMOs, IP as a factor in RandD; IPs of relevance to Biotechnology and few Case Studies History of GATT and TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 and recent amendments, Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees, Invention in context of "prior art"; Patent databases; Searching, International Databases.

Practicals based on theoretical syllabus.

PG SEMESTER - 4

BIOS1001: Understanding trends in Modern Biology Research (Journal Club)

10 most outstanding recent publications in the relevant field of work would be discussed thoroughly and students will be assessed based on Group Discussions/ Seminar Presentation and a Written examination where questions will be set from the discussed Research articles

BIOS1002A (An experimental approach to the study of Biomolecules)

1. **Methods for isolation, purification and analysis of DNA**: Overview of genomic DNA, plasmid DNA preparation, DNA purification, DNA Quantitation (Spectrophotometric and Electrophoresis), Southern blotting; Probe labelling, purification and hybridization; Autoradiography and data analysis.
2. **Commonly used techniques In DNA and RNA analysis:** PCR, Primer design for PCR, Sources of problem in PCR and troubleshooting, Hot Start PCR, Touchdown PCR, Nested PCR, RT PCR, Quantitative (real time) PCR, Long fragment PCR, Inverse PCR, Isolation of RNA from cells and

tissues, northern blotting, analysis of RNA by nuclease protection, primer extension analysis, quantitation of RNA transcript, *in situ* hybridization, RNA interference

4. **An overview of tools for overexpression and purification of Recombinant protein**: Choosing the correct expression host and vector, features of expression vectors, Protein fusion tags, solubilization, pre fractionation and removal of contaminants, dialysis, molecular exclusion chromatography, isoelectric precipitation, salting in, salting out, solvent fractionation, electrophoresis- paper and SDS-PAGE, ion exchange chromatography, adsorption chromatography, affinity chromatography.
5. **Taking a proteomic approach for the study of proteins**: Preparation of sample for proteomic analyses, 2D PAGE: Isoelectric focusing (IEF). Choice of pH gradient. IPG strips, peptide sequencing by classical and modern methods (mass spectrometry); determination of pI of amino acids and peptides; stepwise characterization of complex proteomes, Peptide Mass Fingerprinting, Use of proteomics in clinical analysis, Identification of posttranslational modifications, Peptide sequencing by classical and modern methods; Determination of pI of amino acids and peptides.
6. **Assaying DNA-Protein as well as Protein-Protein interactions:** Filter Binding, EMSA, DNase footprinting, ChIP, ChIP-chip, ChIP-Seq, Next generation sequencing technology applied to ChIP, Two hybrid assay, Immunoprecipitation/Co-immunoprecipitation. TAP-tag method, Far western blotting, Phage display, Protein arrays, Crosslinking, FRET.
7. **Mammalian Cell Culture:** aseptic technique, precautions and typical cell culture methods.
8. **A practical approach to microscopy**: discussion on deconvolution, difference between, phase, DIC, epifluorescence and confocal
9. **Discussion on good laboratory practices**: common laboratory hazards, biohazard safety, waste management and disposal

BIOS 1002B (Animal Science and Environmental Biology)

1. **Animals as experimental model:** Criteria for selecting animals as a model for experimental biology; Management of experimental animals and its ethical considerations.
2. **Animal cell culture:** Primary cell culture, sub culture, cell line, kinetics of cell growth; types of culture media and culture techniques; different methods of tissue, organ and embryo culture.
3. **Conservation Biology:** Biodiversity Conservation & Climate Change; Understanding conservation at genetic levels – managing genetic diversity for conservation goals.
4. **Molecular and Chemical Ecology:** Concept of molecular ecology, molecular marker in ecology; applications of molecular ecology in wild life forensics, agriculture and fishery; Chemical ecology of host parasite interaction and plant-insect interaction.
5. **Field Biology:** Monitoring of site characteristics; Sampling techniques of static and mobile organism (pitfall trap, quadrate sampling, transects, direct observations, indirect methods, capture techniques, marking individuals, pug mark techniques, radio-tracking etc.).
6. **Environmental Biotechnology:** Microbial management of contaminated land, water, wastewater, solid waste; Xenobiotics and their biotransformation; Bio-fuel and Bio-fertilizer production; Biotechnological control of Disease & Pests.
7. **Molecular Taxonomy:** Phylogenetic analysis by using nucleotide and protein sequences; Different methods of phylogenetic tree reconstruction (Cluster analysis, neighbor-joining method, bootstrap analysis, maximum parsimony and maximum likelyhood methods).
8. **Analysis and Interpreting Information:** Analysis and processing of biological data using different statistical tests; Interpreting and presenting of data as models.

BIOS 1002C (Plant and Microbial Genetic Engineering)

1**. Plant cell culture:** Isolation of single cells, culturing of single cell- different methods, culture cell viability test. Cryopreservation and slow growth cultures, Freezing and storage, thawing and reculture of cells. *In vitro* production of secondary metabolites: Cell suspension culture development- methodology, kinetics of growth and production formation, optimization of culture; Hairy root cultures and their cultivation; Biotransformation

2. **Basic Tools in Plant Molecular Biology, Genetic Engineering and Microbiology:** Cloning strategies - GATEWAY cloning, Chromosome walking, Importance of large scale gene expression studies, quantitative real-time RT-qPCR, microarray, suppression subtractive hybridization, next generation sequencing, expression data normalization and transformation, various *in planta* transformation and selection strategies, Reporter genes, generation of loss-of-function and gain-of-function mutants, genetic complementation, Chloroplast and mitochondrial engineering, gene orthology and paralogy- sequence and phylogenetic analytical tools, *Arabidopsis* (https://www.arabidopsis.org) and rice genome database (http://rice.plantbiology.msu.edu) search, Lyophilizer– application in microbiology, HPTLC, Methods of isolation, purification and polyphasic identification of root nodule bacteria, Nanoparticles- green synthesis and chemical synthesis – advantages, disadvantages and application

3. **Plant stress biology:** Abiotic and biotic stress- types and importance of study, osmotic stress, halophytes and glycophytes, osmolytes and osmoprotectants, Ion homeostasis, various phenotyping methods and parameters- root and shoot growth, stomatal opening and photosynthesis, tissue ion content and uptake, Germination assay, oxidative enzyme assay, role of plant hormones- ABA, Role of important signaling genes in salt and drought stress- SOS pathway, ABRE, DREB

4. Ethnopharmacology: Basic concept of Ethnopharmacology. Natural products research and phytochemistry: *in vitro* secondary metabolite production and quantification via various methods. Role of natural compounds (plant/animal/microbial origin) in drug discovery, formulations and synergism.

5. Microbial bioremediation and bioenergy crops: Molecular mechanisms for microbial resistance to toxic materials (heavy metals, hydrocarbons, drugs); Principle of microbial bioremediation, bioremediation types; different approaches from literature; techniques for generating wild type and site directed mutants of important bioremediation genes; MIC, MMR and MDR techniques; techniques for purification of microbial proteins; protein characterization techniques; buffers and activity assays; basic and advanced microscopy and spectroscopy techniques; bioremediation bioassay techniques. Bioenergy sources: Petroleum plants (petro plants)- hydrocarbons for higher plants like *Hevea* and *Euphorbia*. Algal hydrocarbons, Alcohols: Alcohols as a liquid fuel- Hydrolysis of lignocellulosic materials, Ethanol production, fermentation and recovery of ethanol.

BIOS 1002D (Human Physiology)

1. Study of Environmental Toxicology and its Management: Environmental toxicants –impact on the common man from systems to cells, Effects on the human body-emphasis on the liver, kidney, blood and reproductive tissues, Experimental design for assessment of the toxicities- *in vivo*, *in vitro* and cell line studies, Brief description on methods to assess impact of environmental toxicants, precautions for laboratory work and interpretation of results, Methods to be discussed: Histology, Immunohistochemistry, Biochemical analysis of cellular oxidative imbalance, Enzyme kinetics, ELISA, DNA damage studies: Comet and fragmentation assay, Studies of mRNA and protein expression, Apoptotic Studies, Studies on the management of the toxicities and its impact on society.

2. Tools of molecular reproductive biology: Recombinant DNA technology- restriction enzymes, recombination of DNA, gene libraries, cloning vectors, Techniques for DNA analysis- Gel electrophoresis, southern blot hybridization, DNA finger printing and profiling, polymerase chain reaction, generation and identification of gene mutations, fluorescence in-situ hybridization, DNA Microarray analysis- use of Microarrays for discovery of new biomarkers for reproductive traits, Disease specific genomic analysis (DSGA), Mammalian cell culture: Primary cell culture (specifically granulosa cells and sertoli cells), maintaining embryonic stem cells in culture and cryopreserving them, Rat/mice embryo manipulation.

3. Food Science assessment of Nutritional status and study of antimicrobial activities: Assessment of nutritional status, Neutraceuticals, phytochemicals and their nutritive role against acute and chronic disorders, Biochemical assays of food and blood constituents, Antibiotic and antibiotic resistance, isolation and study of antibiotic resistant strain, determination of MIC and MBC of antibiotics, methods of study of antibiotic resistant plasmids.

4: Ergonomics, Work Physiology & Occupational Management: Anthropometric measurements: indicators of growth pattern, malnutrition, obesity, fitness and performance, Body Composition Analysis and its implications in health and work, Application of ergonomics in industry and agriculture

- Psychophysical methodology and evaluation of manual material handling.
- Evaluation of metabolic load and physical stress.
- Evaluation of cardiopulmonary stress
- Application of musculoskeletal and work history questionnaire.
- Assessment of noise, vibration and illumination levels.

Biomechanics: Evaluation of postural stress in different work states.v

BIOS1002E (Recombinant DNA technology and downstream processing)

1. **Molecular cloning of a target gene:** (a) Choice of domains (b) PCR strategies: Primer designing for PCR and site directed mutagenesis. (c) Choice of expression system and vectors: *E. coli*, baculovirus, *Pichia pastoris* (d) Cloning methods: restriction digestion, TA cloning, recombination, LIC (e) Transformation of competent cells
2. **Protein expression in prokaryotic system:** expression strategies, optimization, improving protein solubility and stability, reducing protein toxicity in cells, cell free expression systems and co-expression, high throughput expression system
3. **Protein expression in mammalian system**: use of different vectors - plasmids, advenoviral, retroviral and lentiviral systems
4. **Generation of stable cell lines** - use of transient transfection and stable transfection
5. **Gene knock-down in mammalian system** - Advantages and disadvantages over gene knockouts
6. **Introduction to CRISPR Technology**
7. **Advanced DNA sequencing methods**
8. **Protein purification methods** - combination of separation techniques e.g. chromatography, filtration and precipitation to achieve functionally pure protein; Fast Protein Liquid Chromatography and high-throughput protein production
9. **Methods of studying macromolecular interactions in mammalian system**: (a) protein-protein interaction: Immunoprecipitation, Immunofluorescence and Mass Spectrometry (b) DNA-protein interaction: CHIP assay

BIOS 1003 (Theoretical)

Review of literature

BIOS 1091 (Practical)

Project related lab

BIOS 1092 (Practical)

M.Sc Dissertation thesis and oral presentation