Institute of Health Sciences, Presidency University, Kolkata

Semester-wise Paper codes of the Four-years Bachelor's in Science (Honours) with Research in Biotechnology (under Choice Based Credit System)

SEM	MAJOR COURSE (C)	ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)	SKILL ENHANCEMENT COURSE (SEC)	VALUE ADDED COURSE (VAC)	MINOR COURSE (MC)	MULTI DISCIPLINARY COURSE (MDC)
I	BITG101C01 BITG102C02	103AECC01			BITG104MC01	BITG141MDC01A/ BITG141MDC01B
II	BITG151C03 BITG152C04	153AECC02			BITG154MC02	BITG191MDC02A/ BITG191MDC02B BITG192MDC03A/ BITG192MDC03B
III	BITG201C05 BITG202C06		BITG203SEC01	ENVS204VAC01	BITG205MC03	
IV	BITG251C07 BITG252C08		BITG253SEC02	BITG291VAC02	BITG255MC04	
V	BITG301C09 BITG302C10 BITG303C11		Summer Internship (BITG341SI01)			
VI	BITG351C12 BITG352C13 BITG353C14 BITG391C15					
VII	BITG401C16 (Elective) BITG402C17 (Elective) BITG441C18 (Elective) BITG442C19 (Elective)				BITG443MC05	
VIII	BITG451C20 (Elective) BITG452C21 (Elective) BITG491C22 (Elective) BITG492C23 (Elective)				BITG493MC06	

Course modules, Credit allocation, Evaluation method and Marks distribution for the 8-Semester B.Sc. (Honors) with Research in Biotechnology under CBCS offered by Institute of Health Sciences, Presidency University

Sem	Course	Paper Code	Course Name	Credits			Evaluation Pattern (Marks)			Classes per Week (h)	Course Type (T/S)
				Theo.	Pr.	Total	Theo.	Pr./ Cont.	Total		
I	Major course	BITG101C01	Biochemistry & Metabolism	4	2	6	70	30	100	8	T
I	Major course	BITG102C02	Plant and Animal Physiology	4	2	6	70	30	100	8	T
I	AECC	103AECC01	English Communication	4		4	100		100	4	T
I	Minor course	BITG104MC01	Chemistry-1	4	2	6	70	30	100	8	T
I	MDC	BITG141MDC01A/ BITG141MDC01B	Science for Human Welfare/ Music for Mental Health	3		3		50	50	3	S
I	**Total semester credits and marks**					**25**			**450**		
II	Major course	BITG151C03	Cell Biology	4	2	6	70	30	100	8	T
II	Major course	BITG152C04	Microbiology	4	2	6	70	30	100	8	T
II	AECC	153AECC02	Bengali / Hindi (MIL)	4		4	70	30	100	4	T
II	Minor course	BITG154MC02	Chemistry-2	4	2	6	70	30	100	8	T
II	MDC	BITG191MDC02A/ BITG191MDC02B	Science Communication/ Survival Strategies of Living Things	3		3		50	50	3	S
II	MDC	BITG192MDC03A/ BITG192MDC03B	Society and Behavior/Life Through the Lenses	3		3		50	50	3	S
II	**Total semester credits and marks**					**28**			**500**		
III	Major course	BITG201C05	Molecular Biology	4	2	6	70	30	100	8	T
III	Major course	BITG202C06	Genetics and Developmental Biology	4	2	6	70	30	100	8	T
III	SEC (Major)	BITG203SEC01	Bioethics & Biosafety in Biotechnology	3	1	4	70	30	100	5	T
III	VAC	ENVS204VAC01	Environmental Science	3		3	50		50	3	T
III	Minor course	BITG205MC03	Computational & Statistical Methods-1	4	2	6	70	30	100	8	T
III	**Total semester credits and marks**					**25**			**450**		
IV	Major course	BITG251C07	Immunology	4	2	6	70	30	100	8	T
IV	Major course	BITG252C08	Recombinant DNA Technology	4	2	6	70	30	100	8	T
IV	SEC (Major)	BITG253SEC02	Analytical Techniques in Biotechnology	4	1	5	70	30	100	6	T
IV	VAC	BITG291VAC02	Clinical Biochemistry	3		3		50	50	3	S
IV	Minor course	BITG255MC04	Computational & Statistical Methods-2	4	2	6	70	30	100	8	T
IV	**Total semester credits and marks**					**26**			**450**		
V	Major course	BITG301C09	Plant and Animal Biotechnology	4	2	6	70	30	100	8	T
V	Major course	BITG302C10	Emerging Techniques in Biotechnology	4	2	6	70	30	100	8	T
V	Major course	BITG303C11	Nanotechnology and Tissue Engineering	4	2	6	70	30	100	8	T
V	Summer training	BITG341SI01	Summer Internship		4	4		100	100		S
V	**Total semester credits and marks**					**22**			**400**		

VI	Major course	BITG351C12	Bioprocess Engineering and Technology	4	2	6	70	30	100	8	T
VI	Major course	BITG352C13	Omics Technology	4	2	6	70	30	100	8	T
VI	Major course	BITG353C14	Food and Environmental Biotechnology	4	2	6	70	30	100	8	T
VI	Major course	BITG391C15	Intellectual Property Rights and Bioentrepreneurship	6		6		100	100	12	S
VI	**Total semester credits and marks**					**24**			**400**		
VII	Major course Elective	BITG401C16	Set1- A/ B /C/D/E	4		4	35	15	50	4	T
VII	Major course Elective	BITG402C17	Set1- A/ B /C/D/E	4		4	35	15	50	4	T
VII	Major course Elective	BITG441C18	Research Journal Presentation		4	4		50	50	4	S
VII	Major course Elective	BITG442C19	Research Dissertation		4	4		50	50	4	S
VII	Minor course	BITG443MC05	Research Methodology	4		4		50	50	4	S
VII	**Total semester credits and marks**					**20**			**250**		
VIII	Major course Elective	BITG451C20	Set2- A/ B /C/D/E	4		4	35	15	50	4	T
VIII	Major course Elective	BITG452C21	Set2- A/ B /C/D/E	4		4	35	15	50	4	T
VIII	Major course Elective	BITG491C22	Research Grant Writing		4	4		50	50	4	S
VIII	Major course Elective	BITG492C23	Research Dissertation		8	8		100	100	16	S
VIII	Minor course	BITG493MC06	Research and Publication Ethics	4		4		50	50	4	S
VIII	**Total semester credits and marks**					**24**			**300**		
	Total (4 yrs, 8 semester) credits and Marks					**194**			**3200**		

Abbreviations used:

C- Core/Major course; MC- Minor course; AECC- Ability Enhancement Compulsory Course; SEC- Skill Enhancement Course; MDC- Multi Disciplinary Course; VAC- Value Added Course.

Th.- Theory; Pr.- Practical; Cont.- Continuous assessment; T- Taught course; S- Sessional course

Elective courses during Semester VII and VIII:

Set	Paper Code	Course Name
Set1- A/ B /C/D/E	BITG401C16-17A	Clinical Immunology
	BITG401C16-17B	Nucleic Acid biology and Epigenetics in Diseases
	BITG401C16-17C	Cell Biology of Human Diseases
	BITG401C16-17D	Molecular Endocrinology and Endocrinopathies
	BITG401C16-17E	Pharmaceutical Biotechnology & Drug Design
Set2- A/ B /C/D/E	BITG401C20-21A	Medical And Molecular Virology
	BITG401C20-21B	Medical Biotechnology
	BITG401C20-21C	Neurobiology of Diseases
	BITG401C20-21D	Agricultural & Microbial Biotechnology
	BITG401C20-21E	Regenerative Medicine

Aims and Objectives

The aims of this course are to build basic knowledge of various organisms from virus to bacteria to plant and animals, biochemical and biological processes in the cells and tissues of these organisms. Emphasis will be given to the molecular details of these processes in normal and diseased conditions. This course will aim to understand in detail the pathways of pathogenesis of various organisms, recent technological advances to study these processes and to understand how to utilize the acquired knowledge to design or develop novel strategies for biomedical or biotechnological advancement.

Program outcomes

On completion of this course, students should gain fundamental knowledge on various aspects of biotechnology and should be able to comprehend the molecular basis of numerous pathological conditions that arose from various interactive pathways of different cellular organelles in both human and plant systems. Students should be able to perform various wet lab and computational experiments to analyze an observation. They should learn to analyze, present, and write scientific literature. The students should gain the ability to rationally design experimental strategies to develop a biomedical or biotechnological research project, to conduct experiments of a project, and to finally present their plans/data. They should also develop basic ideas on how a biotechnology industry runs by connecting research and technology while complying with rules of biosafety, ethics, and intellectual property rights.

Program specific outcomes

The students should be able to make rational decisions about their career in fields such as academics, biomedical research, scientific writing, biotechnology industries or to pursue an entrepreneurship idea in the relevant field based on their knowledge and experience gathered during this course.

Teaching-learning process

Teachers with expertise in a certain field will teach that module by having a proper idea of the curriculum, assessing learning needs, and establishing specific learning objectives. Teachers will be in continuous interaction with the students so that the various teaching and learning strategies can be implemented, while maintaining the students' motivation and curiosity about the subjects. Special care will be taken for underperforming students to make them feel confident about the subject.

Mode of assessment

Teaching will include lectures (online or offline), hands-on training, laboratory dissertation and industrial visit. Evaluations will be in two parts- internal or continuous assessment and final assessment. Both time-bound written and oral examinations will be held. The presentations and interaction during presentations will be evaluated in an objective manner. Quizzes and group discussion will be conducted for continuous assessment. Regular performance for the laboratory courses will also be assessed in an objective manner.

Major courses (C 1-23, with elective core courses C 16, 17, 20, 21)

(*Offered to the students of Biotechnology***)**

SEMESTER I

BITG101C01: Biochemistry & Metabolism

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: The foundations of biochemistry

Cellular and chemical foundations of life, chemical basis, Miller experiment, simple organic compound to generation of complex biomolecules

Unit II: Biomolecules and their functions

Carbohydrates: Monosaccharides- structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non- reducing disaccharides. Polysaccharides- homo and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids. Carbohydrates as informational molecules, working with carbohydrates.

Lipids: Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacylglycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution, and role of membrane lipids.

Amino acids and proteins: Structure and classification, physical, chemical and optical properties of amino acids. Amino acids and their properties - hydrophobic, polar and charged. Organization of protein structure into primary, secondary, tertiary, and quaternary structures. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns.

Unit III: Nucleic acids

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. The concept of the genetic code. Experiment to show that DNA is the genetic material. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Unit IV: Enzyme Kinetics

Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories. Michaelis-Menten equation, Hill equation, Mechanism of enzyme inhibition- competitive, non-competitive, allosteric and irreversible inhibition.

Unit V: Energy Metabolism

Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Oxidative phosphorylation

Unit VI: Fatty Acids and Amino Acids Metabolism

Fat absorption and transport, Beta oxidation of saturated and unsaturated fatty acids, MUFA and PUFA, amino acid catabolisms, urea-ornithine cycles, diseases associated with the fatty acid and amino acid metabolisms.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Safety measures in laboratories.
2. Determination of pKa of acetic acid and glycine.
3. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
4. Separation of amino acids/ sugars/ bases by thin layer chromatography.
5. Estimation of vitamin C.
6. Estimation of proteins using UV absorbance and Biuret method.
7. Microassay of proteins using Lowry/Bradford method.

Recommended Textbooks and Reference books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
2. Biochemistry (2010) 4th ed., Voet, D., & Voet JG, John Wiley & Sons, Inc. (New York).
3. Biochemistry (2023) 10th ed. Berg JM, Gatto Jr. GJ, Hines J, Tymoczko JL, Stryer L., W.H. Freeman and Company (New York).
4. Textbook of Biochemistry with Clinical Correlations (2010) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York).

BITG102C02: Plant and Animal Physiology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. Plant physiology

Unit I: Transport and Translocation of Water and Solutes

Plant water relationship: Water Potential, water absorption by roots, aquaporins, symplast, apoplast, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration, anti-transpirants, mechanism of stomatal movement. Mineral nutrition and Translocation in the phloem: Essential and beneficial macro and micronutrients, criteria for essentiality, mineral deficiency symptoms, Soil as a nutrient reservoir, Phloem loading and unloading, Source-sink relationship.

Unit II: Biochemistry and Metabolism

Photosynthesis: Photosynthetic pigments, Photosystems, Photophosphorylation, Calvin cycle, Photorespiration, CAM plants. Respiration and lipid metabolism: EMP pathway, TCA cycle, Oxidative pentose phosphate pathway, Mitochondrial electron transport system. ß-oxidation, gluconeogenesis. Nitrogen metabolism: dinitrogen fixation, nodule formation, nitrate reduction and ammonia assimilation.

Unit III: Growth and Development

Plant growth regulators: Discovery, chemical nature and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Photomorphogenesis: Photoperiodism, vernalization, seed dormancy. Physiology of Senescence and aging, programmed cell death.

B. Animal physiology

Unit I: Digestion and Respiration

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

Unit II: Circulation

Composition of blood, Plasma proteins & their role, blood cells, hematopoiesis, mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

Unit III: Muscle Physiology and Osmoregulation

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

Unit IV: Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters. Mechanism of action of hormones (insulin and steroids). Different endocrine glands– Hypothalamus, pituitary, ovary, testis, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions. Circadian Rhythm and Thermoregulation

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Measurement of osmotic pressure by weighing/plasmolytic method.
2. Determination of loss of water by transpiration.
3. Estimation of total chlorophyll and carotenoid content in leaves.
4. Measurement of seed viability.
5. Estimation of hemoglobin.
6. Counting of mammalian RBCs
7. Determination of total leukocyte count (TLC) and differential leukocyte count (DLC)
8. Measurement of amylase enzyme activity
9. Hematoxylin and Eosin staining of tissue sections

Recommended Textbooks and Reference books:

1. Plant Physiology and Development. (2014)., 6th ed., Taiz L, Zeiger E, Møller IM, Murphy A., Sinauer Associates Inc
2. Biochemistry and Molecular Biology of plants (2015) 2nd ed., Buchanon BB., Wiley.
3. Plant Physiology (2009), 1st ed., Mukherjee S, Ghosh A., New Central Book Agency.
4. Introduction to Plant Physiology (2013) 4th ed., Hopkins W.G, Hiiner N.P., Wiley India Pvt Ltd.
5. Fundamental of Plant Physiology (2017)., 19th ed., Jain V.K., S. Chand and Company.
6. Guyton & Hall Textbook of Medical Physiology (2020) 3rd South East Asia ed., Hall JE, Hall ME., Elsevier Health Science.
7. Vander's Human Physiology (2022)., 16th ed., Widmaier E, Raff H, Strang K., McGraw-Hill, Higher Education.
8. Human Physiology (2020)., 13th ed., C.C. Chatterjee CBS Paubslishers.
9. Gray's Anatomy: The Anatomical Basis of Clinical Practice (2020), 42nd ed, Standring S, Elsevier.

SEMESTER II

BITG151C03: Cell Biology
Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Introduction to Cells
Classification of organisms by cell structure, cell theory, Overview of prokaryotic and eukaryotic cells, plant and animal cells; Compartmentalization of eukaryotic cells, cell fractionation. Exceptions to cell theory- Phages, Viroids, Mycoplasmas, Viruses, Prions. Basic Microscopic technique to visualize cells and organelles: Light microscopy- lenses and microscopes, resolution: Rayleigh's Approach.

Unit II: Cell wall and membrane
Chemical composition, functions and variations in prokaryotic and eukaryotic cells (primary and secondary wall), Glycocalyx; Cell-cell interactions/junctions, pit connections in plants and animals.
Chemical components of biological membranes, organization and Fluid Mosaic Model. Membrane as a dynamic entity. Membrane transport- active and passive transport, proton pumps associated (Na-K, Ca-calmodulin etc. and their distribution), phagocytosis, pinocytosis, exocytosis, endocytosis.

Unit III: Extracellular Matrix and Signal transduction
Extracellular matrix- Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, regulation of receptor expression and function. Signalling molecules and their receptors, and functions; G-protein coupled receptor, Receptor Tyrosine Kinase (RTK), cytokine receptors. Intracellular signal transduction pathways; signalling networks and cross talk; Bacterial signal transduction.

Unit IV: Nucleus
Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane; Chromosomes and their structure. Nucleolus, rRNA processing.

Unit V: Cellular organelle
Endoplasmic reticulum: Structure, function including role in protein sorting. Golgi complex: Structure, biogenesis and role in protein secretion. Lysosomes-Structure and functions. Ribosomes: Structures and role in protein synthesis. Mitochondria and Chloroplasts: Structure, biogenesis and function.

Unit VI: Cytoskeleton
Structure, organization and function of microtubules, microfilaments, intermediate filaments. Molecular motors. Role of cytoskeleton in cellular traffic.

Unit VII: Mitosis and meiosis and their regulation

Cell cycle regulation, checkpoints, aneuploidy; Apoptosis, Necrosis and Autophagy; Differentiation and Proliferation. Molecular basis of tumorigenesis- Oncogenes and tumor suppressor genes and metastasis.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Light microscopic observation of prokaryotic cells and eukaryotic cells & tissues
2. Cellular fractionation
3. Determination of cell number (mammalian cells) by hemocytometer
4. Determination of cell proliferation of prokaryotic and eukaryotic cells
5. Visualization of subcellular structures and organelles
6. Demonstration and study of cell cycle phases by flow cytometric analyses

Recommended Textbooks and Reference books:

1. Molecular Biology of the Cell (2022) 7th ed., Alberts B, Heald R, Johnson A, Morgan D, Raff M, Roberts K, Walter P., WW Norton & Co.
2. Molecular Cell Biology (2021) 9th ed., Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A., W H Freeman & Co
3. The Cell: A Molecular Approach (2019) 5th ed., Cooper, G.M., Hausman, R.E., OUP USA

BITG152C04: Microbiology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: History and Development of Microbiology

Development and scope of Microbiology. Theory of Spontaneous generation, Germ theory of disease. Contributions of Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich, Martinus W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology. Contributions of Indian scientists in Microbiology; Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques. The Scope and future of microbiology.

Unit II: Microbial Evolution and Systematics

Early Earth and the origin and diversification of Life. Microbial Diversification: Consequences Earth's Biosphere, Endosymbiotic origins of eukaryotes. Aim and principles of classification, Binomial Nomenclature, Basic idea about Hackel, Whittaker's five Kingdoms concept. Domain concept of Carl Woese's (Archaea, Bacteria, Algae, Fungi, Protozoa). Bergey's Manual. Bacterial taxonomy, concept of species, taxa, strain; Characters used in bacterial systematics. Strategies of viral sustainability.

Unit III: Diversity of Microbial world

Prokaryotic Phylogeny and Diversity. Bacteria: General characteristics & economic importance with suitable examples of the following groups: Gram Positive, Gram Negative, Firmicutes, Mollicutes, Actinobacteria, Cyanobacteria. Diversity of Archaea: Phylogenetic and Metabolic Diversity, suitable examples and economic

importance. Diversity of fungi and algae. Techniques for determining microbial diversity. Protozoa- general characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia.

Unit IV: Organization of microbial cells

Cell size, shape and arrangements, glycocalyx, capsule, flagella, fimbriae and pili, Composition and detailed structure of Gram positive and Gram-negative cell wall and archaeal cell wall, Gram and acid-fast staining mechanisms, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, cell inclusions, nucleoid, plasmids, lipopolysaccharide (LPS), and L-forms, Endospore: Structure, formation, stages of sporulation. Basic structure of Cyanobacteria, Fungi and algae

Unit V: Growth and Nutrition

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate. Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, selective, differential, enriched media, acid-base indicator. Enriched and enriched media. Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: Bacterial response to stress, Antibiotics mode of action, emergence of drug resistance

Unit VI: Microbial Habitats, Interactions and role in Bio-geochemical Cycles

Soil-Microflora, aero-microflora, aqua-microflora; Microbes in human body (an overview); Dispersal of microbes. Microbe-Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Plant Growth Promoting Rhizosphere (PGPR) organisms. Microbe-animal interaction: Nematophagous fungi and symbiotic luminescent bacteria. Carbon cycle, Nitrogen cycle, Phosphorus cycle, Sulphur cycle

Unit VII: Host pathogen interaction

Mechanism of microbial pathogenesis (bacteria, virus, yeast, parasites), genetics of pathogenicity, and virulence. Colonization, Association, Adhesion, and Invasion of host tissue. Alteration of host cell behavior by pathogens, Pathogenicity of bacteria (Vibrio, Tuberculosis, Helicobactor, Salmonella, Streptococcus, Pneumococcus, Clostridium); Parasites (Plasmodium, Entamoeba, Naegleria, Leishmania, Trypanosoma)-mode of action, virulence, Pathogenicity islands. Pathogenic fungi. Pathogenicity of viruses (Hepatitis, HIV, Influenza, Coronavirus). Early Development of Virology, General Properties of Viruses, Baltimore Classification System. The Structure of Viruses, Virus Replication strategies, Cultivation of Viruses, Virus purification and assays.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Principle and application of instruments: Autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter, Laminar air flow, BOD incubator, Biosafety cabinet
2. Preparation and inoculation of culture media for bacterial cultivation: Nutrient Broth, Nutrient Agar, McConkey agar, EMB agar. Slant and stab culture.

3. Isolation of bacterial isolates from environmental samples: Sample collection, serial dilution and plating. Selectin and purification of selected bacterial isolates
4. Staining and microscopic observation of bacteria, fungus and protozoa
5. Basic methos for microbial enumeration: colony- forming units (CFU) and hemocytometer
6. Cultivation, maintenance and preservation of pure bacterial strains

Recommended Textbooks and Reference books:

1. Prescott's Microbiology (2023) 12th ed., Willey J, Sandman K, Wood D., McGraw Hill International.
2. Brock Biology of Microorganisms (2021) 16th ed., Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA., Pearson
3. Principles of Microbiology (2014) 2nd ed., Atlas RM., McGraw Hill Education
4. Microbiology (2023). 5th ed., Pelczar MJ, Chan ECS, Krieg NR. Affiliated East West Press Private Limited New Delhi
5. General Microbiology (2005) 5th ed., Stanier RY, Ingraham JL, Wheelis ML, and Painter PR., McMillan
6. Microbiology: A Laboratory Manual (2010) 9th ed., Cappucino J, Sherman N. Pearson Education Limited

SEMESTER III

BITG201C05: Molecular Biology
Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: DNA replication
DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II: DNA damage, repair and homologous recombination
DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, trans-lesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III: Transcription and RNA processing
RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing, non-coding RNA, RNA interference

UNIT IV: Translation and gene expression regulation
Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Co- and Post-translational modifications of proteins, Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system).

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of genomic DNA from bacterial cells
4. Quantitative analysis of DNA using spectrophotometer
5. Isolation of Plasmid DNA by alkaline lysis method
6. Analyzing circular and linear DNA by agarose gel electrophoresis
7. RNA isolation and analyzing by gel electrophoresis
8. Lactose induction of β-galactosidase

Recommended Textbooks and Reference books:

1. Biochemistry (2010) 4th ed., Voet, D., & Voet JG, John Wiley & Sons, Inc. (New York).
2. Molecular Biology of Gene (2017) 7th ed., Watson JD, Tania AB, Stephen PB, Alexander G, Michael L, Richard L., Pearson.
3. Molecular Biology of the Cell (2022) 7th ed., Alberts B, Heald R, Johnson A, Morgan D, Raff M, Roberts K, Walter P., WW Norton & Co.
4. Molecular Cell Biology (2021) 9th ed., Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A., W H Freeman & Co
5. Lewin's Genes XII (2017) 12th ed., Krebs JE, Goldstein ES, Kilpatrick ST., Jones and Bartlett Publishers
6. Molecular Cloning-A Laboratory Manual (2012) 4th ed., Sambrook J, Green MR., Cold Spring Harbor Laboratory Press.

BITG202C06: Genetics and Developmental Biology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. Genetics

Unit I: Introduction to Genetics

Concepts of gene, alleles and traits; Mendel's laws of inheritance and extensions of Mendelism (Neo-Mendelism); Intragenic and intergenic interactions; Sex-linked inheritance; Linkage and crossing over, Molecular markers and Gene mapping techniques: Chromosome rearrangements and variations; Mutation and mutagens: Extranuclear Cytoplasmic inheritance; Transposable elements: Sex determination.

Unit II: Microbial and Yeast Genetics

Identification and selection of mutants; Plasmids; Methods of gene transfer; Phage genetics: lytic and lysogenic switch; Virulent and temperate phage; Phage resistance; Transduction; Meiotic crosses, tetrad analysis in yeast, and recombination mapping.

Unit III: Human Genetics

Pedigree analysis; Karyotype, banding, nomenclature of chromosome subdivisions and gene mapping; Genetic disorders; Genetic counselling; Population genetics- genetic drift, neutral evolution; Fisher's theorem, Hardy-Weinberg equilibrium, population bottlenecks, genetic fitness. Quantitative genetics - complex traits.

B. Developmental Biology

Unit I: Morphogenesis and organogenesis in plants

Organization of shoot and root apical meristem, shoot and root development. Leaf development and phyllotaxy. Transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*.

Unit II: Gametogenesis and Fertilization

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization, prevention of polyspermy. Different types of eggs on the basis of yolk.

Unit III: Embryonic development and differentiation

Cleavage, Blastulation and Gastrulation. Formation and differentiation of primary germ layers, Fate Maps in early embryos, The Organizer Concept. Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation. Concept of primary, secondary and tertiary embryonic induction, neural induction and induction of vertebrate lens.

Unit IV: Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers. Development of behaviour: constancy & plasticity, Extra embryonic membranes. Placentation in mammals: formation and types of placentas, hormonal factors, functions of placenta. Gene regulation during development: Segmentation in Drosophila, homeotic gene complexes and the Hox genes.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Studying bacterial conjugation.
2. Studying bacterial transduction.
3. Preparation of plant chromosomes and karyotype analysis.
4. Setting up monohybrid and dihybrid crosses of *Drosophila*.
5. Identification of developmental stages of chick and frog embryo using permanent mounts.
6. Study of chick development from fertilized eggs and preparation of a temporary stained mount of chick embryo.
7. Analysis of the developmental stages and mutants of *Drosophila.*
8. Study of epithelial tissue by methylene blue staining.
9. Measurement of animal/plant cell size using ocular and stage micrometer.

Recommended Textbooks and Reference books:

1. Developmental Biology (2006) 8th ed, Gilbert S. F., Sinauer Associates, Inc., Publishers.
2. An introduction to Embryology (2004) 5th ed., Balinsky B.I., International Thomson Computer Press.
3. Analysis of Biological Development (2006) 2nd ed., Kalthoff K., McGraw-Hill Education.
4. Patten's Foundation Of Embryology (2004) 6th ed., B.M. Carlson., McGraw Hill Education.
5. Principles of Genetics (2006) 8th ed., Gardner EJ, Simmons EJ, Snustad DP., Wiley.
6. An introduction to Genetics Analysis (2020) 12th ed., Griffiths AJF, Doebley J, Peichel C., WH Freeman.
7. Snyder and Champness Molecular Genetics of Bacteria (2020) 5th ed., Henkin TM, Peters JE., ASM Press
8. Microbial Genetics (2008) 2nd ed., Maloy SE, Cronan Jr JE, Freifelder D., Narosa Publishing House

SEMESTER IV

BITG251C07: Immunology
Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Components of the immune system
History of Immunology, innate immune response (PRRs, Neutrophils, Dendritic cells, plant innate immunity), complement system, humoral and cellular immunity and its components

Unit II: Cells and organs of the immune system
Overview of lymphoid system, cells of the immune system, primary and secondary lymphoid organs, tertiary lymphoid tissues

Unit III: Antigen and antibodies
Antigen concept, criteria of antigens, immunogen, antibodies (structure, specificity, diversity, VDJ recombination), antigen-antibody interactions.

Unit IV: Receptors and Signaling
T-cell and B-cell receptors, diversity, receptor ligand interaction, signaling in T-cell and B-cell, Cytokines and chemokines)

Unit V: Immunological memory
Development of T and B cells. T and B cell activation, differentiation and memory

Uni VI: Antigen processing and presentation
Major histocompatibility complex, MHC restriction, Antigen processing and antigen presentation (endogenous and exogenous processing pathways, Immune tolerance

Unit VII: Hypersensitivity and autoimmunity
Type I (Allergy), Type II (antibody mediated) and Type III (immune complex mediated) and Type IV (delayed type) hypersensitivity reaction, autoimmunity and types

Unit VIII: Basic Immunological techniques
Generation of monoclonal antibodies, Concepts of vaccine, Single chain antibody. Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Determination of Blood group – A, B, AB and O

2. Precipitation reaction by double immunodiffusion (Ouchterlony method) and radial immunodiffusion (Mancini's method)
3. Detection of antigens or antibodies by ELISA – Indirect and Sandwich ELISA
4. Isolation and purification of IgG from serum
5. Immunoelectrophoresis
6. Immunoprecipitation assay
7. Latex agglutination
8. Immunoblotting assay for protein detection

Recommended Textbooks and Reference books:

1. Kuby Immunology (2023) 8th ed., Stanford S, Owen JA, Punt J, Jones P., W.H. Freeman Macmillan learning.
2. Janeway's Immunobiology (2022) 10th ed., Murphy K, Weaver C, Berg L., WW Norton & Co.
3. Cellular and Molecular Immunology (2021) 10th ed., Abbas AK, Lichtman AH, Pillai S., Elsevier - Health Sciences Division

BITG252C08: Recombinant DNA Technology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Molecular tools

Restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication

Unit II: Genetic manipulations

Restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription. Genome mapping, DNA fingerprinting, Genome engineering/editing tools –TALENs, ZFNs, CRISPR- concept and development.

Unit III: Applications of Genetic Engineering

Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

Unit IV: Principle and applications of Polymerase chain reaction (PCR)

Primer-design, and RT- (Reverse transcription) PCR; Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Unit V: Genetic engineering in plants

Use of Agrobacterium tumefaciens and Arhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Isolation of chromosomal DNA from plant cells and restriction digestion analysis
2. Restriction digestion and mapping of plasmid DNA
3. Preparation of competent cells
4. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
5. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
7. Gene cloning and recombinant screening
8. Expression of recombinant protein and analysis by SDS-PAGE

Recommended Textbooks and Reference books:

1. Principle of gene manipulation and genomics (2014) 7th ed., Primrose SB, Twyman RM., John Wiley Blackwell.
2. Gene cloning and DNA analysis: An introduction (2020) 8th ed., Brown T.A., Wiley Blackwell
3. Molecular Cloning-A Laboratory Manual (2012) 4th ed., Sambrook J, Green MR., Cold Spring Harbor Laboratory Press.

SEMESTER V

BITG301C09: Plant and Animal Biotechnology
Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. Plant Biotechnology

Unit I: Basics of plant tissue culture

Sterilization procedures, design of laboratory and commercial tissue culture facility. Tissue culture media: Media for in vitro culture, media composition, plant growth regulators; selection of suitable media. Concept of totipotency; Callus culture, Organ culture, shoot tip culture, apical Meristem culture, embryo culture, ovary culture, ovule culture. Protoplast culture, protoplast fusion.
Micropropagation, somatic embryogenesis and synthetic seed production.

Unit II: Plant genetic transformation

Vectors: Types of vectors used in higher plants, Tumour-inducing (Ti) plasmids, binary and cointegrate vectors, Plant selection markers, reporter genes (GFP, luciferase, GUS), Methods of transformation: Agrobacterium-mediated transformation, pollen-mediated gene transfer. Physical delivery methods, protoplast transformation. Analysis of transgenics, male sterility (nuclear and cytoplasmic). Exploitation of male sterility for hybrid vigor induction.

Unit III: Genetic engineering for crop improvement

Genetic engineering for biotic and abiotic stress tolerance, Role of Antioxidants, Osmoprotectants, Transporters, Transcription factors, Pathogenesis related proteins etc. in plant stresses, Engineering for biotic stresses tolerance (insect resistance, Pathogen resistance). Resistance against abiotic stresses (drought tolerance, salinity tolerance). Improvement of seed and fruit quality, TMT and FLAVR SAVR tomato). Molecular markers (SSR etc.), marker assisted breeding.

Unit IV: Plant as Bioreactors

The advantages of utilizing transgenic plants as bioreactors, Selection of host plant, Molecular Farming, Recombinant protein production in plants (Antibody, Edible vaccine, Pharmaceutical and non-pharmaceutical protein production).

B. Animal Biotechnology

Unit I: Gene transfer methods in animals

In vitro fertilization in human, Induced breeding in fish, Microinjection, Embryonic Stem cell, gene transfer, Virus (Retrovirus, Lentivirus, Adenovirus and Adeno-associated virus) mediated gene transfer.

Unit II: Introduction to Transgenesis

Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

Unit III: Animal propagation

Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications: Embryonic and adult stem cells; extrinsic and intrinsic self-renewal factors; Stem cell therapies – cell-based therapies, therapeutic cloning, cord blood stem cells.

Unit IV: Genetic modification in Medicine

Molecular markers in detection of cancer: molecular diagnosis of Burkitt's lymphoma, chronic myeloid leukemia and carcinomas. Gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Seed sterilization, germination and preparation of explant for plant tissue culture.
2. Tissue culture mediated regeneration of tobacco plants by using leaf disc as explant.
3. Preparation of competent cells of *Agrobacterium spp*.
4. Transformation of competent *Agrobacterium spp*. cells with suitable vector.
5. Demonstration of steps of transgenic plant development.
6. Preparation of media, adherent and suspension culture techniques and maintenance.
7. Isolation of PBMCs from fresh blood.
8. Transfection of plasmid DNA in adherent cells.
9. Visualization of localization of a transfected reporter gene by fluorescence microscopy.

Recommended Textbooks and Reference books:

1. Plant Tissue Culture and Practice (2003) 1st ed., Bhojwani SS, Razdan MK., Elsevier
2. Plant Biotechnology: The Genetic Manipulation of Plants (2008) 2nd ed., Slater A, Scott NW, Fowler MR., Oxford University Press.
3. Plant Biotechnology (2022) 4th ed., Singh BD., Medtech Publishers.
4. Advanced Biotechnology (2014) 1st ed., Dubey RC., S.Chand & Co., Ltd., New Delhi.
5. Basic Biotechnology (2007) 1st ed., Ignacimuthu S. Tata McGraw Hill.
6. Molecular biology Labfax II: Gene analysis (1998) 2nd ed., Brown TA., Academic Press.
7. Animal cell culture and technology: The basics (2004) 2nd ed., Butler M., Bios scientific publishers.
8. Molecular biotechnology- Principles and applications of recombinant DNA (2009) 4th ed., Glick BR, Pasternak JJ., ASM press.
9. An introduction to Genetics Analysis (2020) 12th ed., Griffiths AJF, Doebley J, Peichel C., WH Freeman.
10. Recombinant DNA genes and genomes- A short course (2007) 3rd ed., Watson JD, Myers RM, Caudy A, Witkowski JK., W. H. Freeman.
11. The Biology of Cancer (2013) 2nd ed., Weinberg RA., W. W. Norton & Company.

BITG302C10 : Emerging Techniques in Biotechnology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Optical microscopy methods

Differential Interference Contrast (DIC) Fluorescence microscopy: Optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture Advanced Microscopy: Confocal microscope-principle, resolution and point spread function, light source: gas lasers & solid-state, detectors; Deconvolution; Atomic force microscopy; Super resolution structured illumination microscopy (SR-SIM); Stimulated Emission Depletion Microscopy (STED); Stochastic Optical Reconstruction Microscopy (STORM); Application of FLIP, FRAP and FLAP in live cell imaging.

Unit II: Biophysical techniques

Protein folding- pathways of protein folding. Analyzing protein structure and function- Fluorescence spectroscopy, FRET, Fluorescence anisotropy; Isothermal calorimetry (ITC); Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD), Infrared spectroscopy (IR), Atomic absorption spectroscopy (AAS), NMR spectroscopy (1D, 2D & multidimensional NMR), X-ray crystallography (XRD), Surface plasmon resonance (SPR) and Dynamic light scattering (DLS) in structure determination.

Unit III: Electron microscopy

Principle of electron microscopy, SEM, TEM, STEM (including 4D-STEM), Cryo-Electron Microscopy and Recent advancements in in situ platforms.

Unit IV: Medical Imaging Techniques

Introduction to macro, micro, and molecular medical imaging. Diagnostic imaging involving X-ray and ultrasound; Basic principles and applications of Computed Tomography (CT); Cutting-edge Magnetic Resonance Imaging (MRI) Techniques: Dynamic Contrast-Enhanced (DCE-MRI), Magnetic Resonance Spectroscopy (MRS), Magnetic Resonance Angiography (MRA) and Functional MRI (fMRI); Nuclear Imaging Modalities: Positron Emission Tomography (PET) and SPECT (Single-photon emission computed tomography); Introduction to the concept of multimodal imaging and molecular theranostics; Recent developments in MRI contrast agents and PET probes for the molecular imaging of cancer, atherosclerosis, and neuroinflammation.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Conformational studies of protein by fluorescence spectroscopy
2. Fluorescence microscopy using expression of a fluorescence-tagged gene in mammalian cells
3. Structural analysis of biomolecules using spectroscopic techniques: UV-Visible, IR, NMR spectroscopy
4. Morphological analysis of biological samples using SEM
5. Relaxometric analysis of MRI contrast agents.
6. Preprocessing of fMRI data

Recommended Textbooks and Reference books:

1. MRI: Basic Principles and Applications (2015) 5th ed., Dale BM, Brown MA, Semelka RC., Wiley–Blackwell.

2. Positron Emission Tomography: Clinical Practice (2004) 1st ed., Bailey DL, Townsend DW, Valk PE, Maisey MN., Springer
3. Molecular Imaging: Basic Principles and Applications in Biomedical Research (2020) 3rd ed., Rudin M., World Scientific Europe Ltd.
4. Organic Spectroscopy (2019) 3rd ed., Kemp W., MACMILLAN
5. Introduction to Spectroscopy (2015) 5th ed., Pavia DL, Lampman GM, Kriz GS, Vyvyan JR, Cengage India Private Limited (2015).

BITG303C11: Nanotechnology and Tissue Engineering

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. Nanotechnology

Unit I: Introduction to Nanobiotechnology

Introduction to nanobiotechnology; Concepts, historical perspective; Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterization of nanomaterials. DNA nanotechnology, Protein & glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Carbon nanotube and its bio-applications,

Unit II: Applications of nanomaterials

Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nano artificial cells, Nanotechnology in organ printing. Nanotechnology in point-of-care diagnostics, Nanoparticles for diagnostics and imaging (theranostics); Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Basics of nanotoxicity, Models and assays for nanotoxicity assessment. Nanotechnology mediated application in agricultural and food biotechnology.

B. Tissue Engineering

Unit I: Introduction to tissue engineering: Cell/extracellular matrix interactions; tissue engineering - its need and current available technologies. Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Synthetic and natural polymers; Bio-fabrication of scaffolds for tissue engineering; Tailoring of Biomaterials; Decellularization methods for scaffold fabrication; Characterization of biomaterials

Unit II: Applications of tissue engineering: Cell-surface interactions - protein adsorption on scaffold; biomineralization on scaffold; cellular activities on scaffold, fate of tissue engineering scaffolds *in vivo.* Applications of tissue engineering.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Green synthesis of nanoparticles
2. Synthesis of superparamagnetic iron oxide nanoparticles (SPION)

3. Study of antimicrobial potential of nanoparticles
4. Preparation of hydrogel
5. Preparation of fiber
6. Cell seeding on scaffolds

Recommended Textbooks and Reference books:

1. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss
2. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
3. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
4. Recent review papers in the area of Nanomedicine.
5. The Principles of Tissue Engineering (4th edition), by Robert Lanza, Robert Langer, and Joseph P. Vacanti. Academic Press (AP). 2013.
6. Biomaterials Science: An Introduction to Materials and Medicine (3rd edition), by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons. Academic Press (AP). 2012

BITG341SI01: Summer Internship

Credit: 4

The students will participate in laboratory-based training on chosen topics related to biotechnology for 8 weeks during the break (June-July) after completing their fourth semester. One student may join a research lab of their choice within the department, at other science departments of Presidency University or at any other university. As part of a research laboratory one student will learn basic laboratory protocols and related techniques, research ethics, the rationale of the research question(s) and will perform experiments to address those questions. One should also prepare a brief report on that study. The student will present the research work done during the summer internship, and this oral presentation will be evaluated by a committee of teachers.

SEMESTER VI

BITG351C12: Bioprocess Engineering and Technology
Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Introduction to Bioprocess Engineering and Technology
Brief history and developments in industrial microbiology.

Unit II: Preparation of medium and selection of industrially important microbial strains
Selection of medium composition, concept and methods of sterilization, microbial growth parameters and environmental factors, kinetics of batch and fed batch fermentation. Synchronous culture, chemostat and turbidostat. Sources of industrially important microbes and methods for their isolation, preservation and maintenance and strain improvement.

Unit III: General concepts and application of fermentation
Fermentation- general concepts, applications, and structure of a fermenter; Range of fermentation process microbial biomass, enzymes, metabolites, recombinant products, transformation process; Components of fermentation process. Types of fermentations- aerobic and anaerobic fermentation, submerged and solid-state fermentation, factors affecting submerged and solid-state fermentation, substrates used in solid-state fermentation and its advantages; Culture media- types, components, and formulations. Sterilization: Batch and continuous sterilization. Bioreactors, membrane bioreactors. Kinetics of microbial growth and death, Monod model, air quality management and air sterilization. Measurement and control of fermentation parameters - pH, temperature, O_2.

Unit IV: Process development and optimization
Process development, Optimization- classical and statistical methods of optimization; Immobilization- different matrices, whole cell, and enzyme immobilization; Advantages and applications of immobilization, large scale applications.

Unit V: Microbial production of industrially important products
Production of ethanol, citric acid; amino acids, wine, beer, vitamins; microbial enzymes, Baker's yeast, mushroom. Production of biopesticides and biofertilizers, Composting and bio-composting.

Unit VI: Downstream Processing
Cell disruption (mechanical, enzymatic, and chemical methods), filtration, flocculation, sedimentation, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Laboratory fermenter sterilization, operations, monitoring and scale-up of selected strain.
2. Optimization of fermentation parameters (pH, temperature)

3. Fermentation of useful microbial products
4. Lyophilization of microbial cells and its revival
5. Mechanical and enzymatic process of microbial cell disruption
6. Downstream processing-Extraction and purification of microbial polysaccharide

Recommended Textbooks and Reference books:

1. Prescott's Microbiology (2023) 12th ed., Willey J, Sandman K, Wood D., McGraw Hill International.
2. Brock Biology of Microorganisms (2020) 16th ed., Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA., Pearson.
3. Industrial Microbiology (2019) 2nd ed., Casida LE., New Age International Private Limited.
4. Principles of Fermentation Technology (2016) 3rd ed., Stanbury PF, Whitaker A, Hall SJ., Butterworth-Heinemann.

BITG352C13: Omics Technology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Genome mapping and sequencing

Concept of Genomics, Genome mapping – Genetic and physical mapping, Genetic markers; methods and techniques used for gene mapping, molecular/genetic markers in genome analysis; molecular markers linked to disease resistant genes. Application of molecular markers in forensic, disease prognosis, genetic counseling and pedigree analyses; linkage analysis, cytogenetic techniques, Fluorescent In Situ Hybridization in gene mapping, somatic cell hybridization, and radiation hybrid maps.

DNA-Sequencing- Manual and Automated sequencing; Genome sequencing projects for model organisms; Human Genome Project (HGP), Next-generation sequencing; Application of Next-Gen Sequencing technologies.

Unit II: Functional Genomics

Transcriptome analysis for identification and functional annotation of gene, Gene function- forward and reverse genetics, Application of genomics, Epigenomics, Proteogenomics, Structural genomics, Metagenomics, Comparative genomics, Personal Genomics, Pharmacogenomics/pharmacogenetics, Pharmacodynamics. gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics. Concept of systems biology and synthetic biology.

Unit III: Proteomics

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, N and C-terminal identification of proteins- Sanger's method, Edman's method, Carboxypeptidase based techniques, Analysis of proteomes. 2D-PAGE. Sample preparation,

solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry-based methods for protein identification, gel free proteomics, De novo sequencing using mass spectrometric data.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM (Online Mendelian Inheritance in Man) database
3. Detection of Open Reading Frames using ORF Finder
4. RFLP analysis
5. Cytogenetics -Giemsa staining
6. Demonstration of chromosomal translocation by FISH
7. Proteomics 2D PAGE database
7. *In silico* 3D structure determination and effect of mutations in protein structures
8. *In silico* identification of signal peptide, nuclear localization signals in a protein structure
9. Blue native PAGE for protein complex determination

Recommended Textbooks and Reference books:

1. Lewin's Genes XII (2017) 12th ed., Krebs JE, Goldstein ES, Kilpatrick ST., Jones and Barltlett Publishers.
2. Modern Biotechnology (1987) 2nd ed., Primrose SB., Blackwell Publishing.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2022) 6th ed., Glick BR, Pasternak JJ, Patten, CL., ASM Press.
4. Molecular Cloning: Molecular Cloning-A Laboratory Manual (2012) 4th ed., Sambrook J, Green MR., Cold Spring Harbor Laboratory Press
5. Principles of gene manipulation and genomics (2014) 7th ed., Primrose SB, Twyman RM., Blackwell JW.
6. Concepts of Genetics (2019). 11th ed., Klug W.S, Cummings MR, Spencer CA., Pearson Education.
7. iGenetics- A Molecular Approach (2009) 3rd ed., Russel PJ., Pearson International.
8. Bioinformatics and Functional Genomics (2022) 3rd ed., Pevsner, J., John Wiley & Sons.
9. Principles of Proteomics (2004) 1st ed., Twyman R., Taylor & Francis.
10. Proteomics: From Protein Sequence to Function (2002) 1st ed., Pennington SR, Dunn MJ., Viva Books Private Limited.

BITG353C14: Food and Environmental Biotechnology

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. Food Biotechnology

Unit I: Microbial Food Spoilage and Food Preservation

Sources of food contamination; factors influencing microbial growth in food. Principles of food spoilage; spoilage of vegetables, fruits, meat products, milk products, sea foods, poultry and canned foods; Methods for detection of spoilage

Principles and methods of food preservation- physical (temperature, irradiation, drying, canning), modifications of atmosphere, control of water activity, compartmentalization; Chemical (Organic acids, food additives. class I and class II preservatives); Control by combination of methods (Hurdle concept); Biopreservation; Food packaging.

Unit II: Foodborne Infections and Intoxication

Overview of Bacterial Toxins. Food borne infections and intoxications- *Clostridium* (Botulism), *Escherichia*, *Listeria and Staphylococcus*

Mycotoxins and types, mode of action of aflatoxins.

Unit III: Uses of Microbes in Food

History, scope and importance of fermented foods; Microbial stress response in food, starter cultures, microbiology of fermented foods. General methods of production- fermented vegetables, meat, beverages; Bread, dairy foods; Probiotics, prebiotics and synbiotics, nutraceuticals (Cr/Se yeast), functional foods and their quality standards. SCP, Quorn and SCO and their Industrial production. Importance of mushroom culture.

Unit IV: Microbial Detection and Food Safety

Conventional Methods, sampling for microbial analysis, qualitative methods of microbial detection and its quantitation, biosensors, controlling the microbiological quality of food, quality and criteria, sampling schemes, Good Hygiene Practices, sanitation in manufacturing and retail trade; food control agencies and their regulation, QC using microbiological control, control at source, codes of GMP, HACCP, DNA barcoding, laboratory accreditation.

B. Environmental Biotechnology

Unit I: Introduction to environment and Environmental Problems

Concept of Ecology and Ecosystem, Environmental problems – Different types of Pollution, ozone depletion, pesticides, greenhouse effect. Stress response mechanisms.

Unit-II: Environmental Toxicology

Environmental toxicants and impact on human health: Heavy metals toxicity (Arsenic, Mercury), Pesticides (Endocrine disruption, Environmental carcinogenicity). Bioaccumulation and Biomagnification. Mode of entry of toxic substance, Concept of Xenobiotic detoxification and Biotransformation, LADME, LD50, IC50. Bioassays for determination of environmental toxicants

Unit III: Biotechnology for remediation of polluted habitats

Bioremediation of soil & water contaminated with oil spills, heavy metals and pesticides. Degradation of lignin and cellulose using microbes. Phyto-remediation. Bioleaching, MEOR

Unit-IV: Biotechnology in Waste Management and Recent Advances

Treatment of municipal waste and Industrial effluents. Bio-fertilizers- symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, Algal and fungal biofertilizers. Energy generation from waste.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Detection and enumeration of indicator and index microorganisms for food borne pathogens (total enterobacteria, total coliform & aerobic spore former).
2. MBRT test of milk samples.
3. Isolation of lactic acid producing bacteria and production of fermented milk products/ Sauerkraut.
4. Calculation of BOD and COD of water sample.
5. Characterization of cellulose/ pectin decomposition, starch hydrolyzing microorganisms from environmental samples.
6. Assessing impact of heavy metal toxicity on cell line by MTT Assay

Recommended Textbooks and Reference books:

1. Food Sciences and Food biotechnology- G.F.G. Lopez, G. Canaas, E.V. Nathan
2. Jacquelyn G. Black, Laura J. Black Microbiology Principles and Explorations Wiley, 9th Edition.
3. James M. Jay, Martin J. Loessner, David A. Golden. Modern Food Microbiology. 7th Edition (2005)
4. Martin R. Adams, Maurice O. Moss. Food Microbiology, Royal Society of Chemistry, 3RD edition 2007
5. Surajit Das, Hirak Ranjan Dash. Microbial Biotechnology- A Laboratory Manual for Bacterial Systems Springer Nature. (2014)
6. Environmental Science, S.C. Santra
7. Environmental Biotechnology, Pradipta Kumar Mohapatra
8. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
9. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
10. Toxicology - principles & applications - Niesink & Jon devries

BITG391C15: Intellectual Property Rights and Bioentrepreneurship

Credit: 6 (**Theory**- 6 Contact hours per week: 6 h; Total credit hour: 64 h)

Unit I: Intellectual Property Rights

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

Unit II: Bioentrepreneurship

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations, export potential etc.

Recommended Textbooks and Reference books:

1. Goel. IPR Biosafety and Bioethics, (2013). Pearson
2. Intellectual Property Rights and Entrepreneurship, Tewari and Bharadwaj, Punjab University

SEMESTER VII

BITG401C16: One of the following - BITG401C16-17A/ BITG401C16-17B/ BITG401C16-17C/ BITG401C16-17D/ BITG401C16-17E

Credit: 4 (Theory: Credit- 4; Contact hours per week: 4 h; Total credit hour: 64 h)

BITG402C17: One of the following - BITG401C16-17A/ BITG401C16-17B/ BITG401C16-17C/ BITG401C16-17D/ BITG401C16-17E

Credit: 4 (Theory: Credit- 4; Contact hours per week: 4 h; Total credit hour: 64 h)

BITG401C16-17A: Clinical Immunology

Unit I: Allergy and chronic inflammation

Basis of allergic reaction, molecular mechanisms of Asthma, wheel and flare reaction, allergic rhinitis, food allergies, eczema, cause and consequences of chronic inflammatory diseases

Unit II: Autoimmunity

Immune tolerance and surveillance, Mechanisms of autoimmunity, Organ specific and Systemic autoimmune disease, Immunodeficiency (Primary and secondary immunodeficiencies)

Unit III: Immune malignancies

Tumor immunology: Oncogene and cancer induction, Tumor antigens, Immune response to tumors, relation between tumor type and nature of immune response; Angiogenesis and tumor metastasis; anti-tumor drug resistance; immunotherapy

Unit IV: Transplantation Immunology and Immunogenetics

Types, mechanism of transplant rejection, prevention of graft rejection, HLA typing, Immunotherapy: immune booster and suppressor based-therapy

Unit V: Infectious disease immunology and vaccinology

Host-pathogen interaction; immunity to pathogens; immune evasion strategies; Immunology of diseases of viral, bacterial, fungal and protozoan origin, vaccines; adjuvants; limitations of vaccination

Unit VI: Experimental Immunology models

Ethics and regulations, inbred and outbred strains, adoptive transfer experiments, transgenic immunological models, knock-in and knock-out models using CRISPR and Cre-Lox system

Recommended Textbooks and Reference books:

1. Kuby Immunology (2023) 8thed., Stanford S, Owen JA, Punt J, Jones P., W.H. Freeman Macmillan learning.
2. Janeway's Immunobiology (2022) 10th ed., Murphy K, Weaver C, Berg L., WW Norton & Co

3. Immunology (Lippincott Illustrated Reviews Series) (2021) 3rd ed., Doan T, Viselli S, Lievano F, Swanson-Mungerson M. Wolters Kluwer Health Publication.

BITG401C16-17B: Nucleic Acid Biology and Epigenetics in Diseases

Unit I: DNA damage and diseases

Oxidative DNA damage, mutations, defects in repair, cancer susceptibility syndrome such as Ataxia-telangectasia, and breast/ovarian cancer syndrome, DNA-based therapeutic measures

Unit II: RNA processing and pathophysiology

PCR-based assays for RNA quantification and gene expression analysis, RNA splicing errors and associated diseases, Non-sense mediated RNA decay and RNA quality control mechanisms in maintaining translational fidelity

Unit III: RNA granules

Different RNA granules, methods for studying the RNA-RNA or RNA-protein interactions, stress granules and neurodegenerative diseases, targeting granules as therapeutic measures

Unit IV: RNA therapeutics

Types of RNA and their potential for the development of therapeutics, RNA interference and its uses in developing therapeutics, Introduction to RNA vaccines, Next-generation sequencing and its impact on RNA therapeutics

Unit V: Epigenetic Regulation: Concepts of chromatin and chromatin remodeling (nucleosome structure and function, higher order compaction, histone proteins), Heterochromatin and Euchromatin.

Unit VI: Chromatin modifications

Histone modifying enzymes (readers, writers and erasers) and chromatin remodelers; Histone Code Hypothesis, DNA methylation, Genome-wide methylation in monozygotic twins, X-chromosome inactivation.

Unit VII: Chromatin Techniques

Nucleosome mapping; MNase digestion; DNaseI footprinting; Restriction enzyme accessibility assay; Chromatin immunoprecipitation; ChIP on Chip, Next Generation Sequencing (NGS) for epigenomics.

Unit VIII: Epigenetics in therapeutics

Epigenetic drugs in various diseases, Inhibitors of histone modifications and chromatin remodelers, Epigenome association mapping.

Recommended Textbooks and Reference books:

1. RNA Worlds: From Life's Origins to Diversity in Gene Regulation; Atkins, John F. (Editor)/ Gesteland, Raymond F. (Editor)/ Cech, Thomas R. (Editor); CSHL Press

2. RNA Worlds: New Tools for Deep Exploration, Cech, T.R., Steitz, J.A., Atkins, J.F., CSHL Press.
3. RNA Interference from Biology to Therapeutics, Howard, Kenneth A., Springer US
4. RNA Therapeutics, Giangrande, Franciscis and Rossi, Academic Press
5. Chromatin & Gene Regulation- Bryan Turner
6. Epigenetics- C. David Allis et al
7. Principles of Gene Manipulation & genomics-Primrose & Twyman

BITG401C16-17C: Cell Biology of Human Diseases

Unit I: Cellular transport: Cell transport, Vesicular Traffic, Secretion, Endocytosis and related diseases (such as cholera, cystic fibrosis, and Wilson disease)

Unit II: Cellular migration: Cell migration and its role in development, Chemotaxis; related developmental disorders and diseases such as cancer.

Unit III: Protein misfolding: Protein processing and folding, Unfolded protein response in ER, and associated diseases.

Unit IV: Organelle biology and related diseases: Autophagy and Mitophagy, Lysosomal storage disorders

Unit V: Cellular cytoskeleton: Microtubule and actin cytoskeleton, post-translational modification of microtubules, microtubule binding and actin-binding proteins; Diseases due to change in cytoskeletal dynamics (such as hypertrophic and dilated cardiomyopathies)

Unit VI: Centriole and cilia: Cilia and flagella, motile and primary cilia, ciliopathies and other rare genetic diseases; Centrosomes and centrioles, Cell cycle regulation and tumorigenesis; Microcephaly

Recommended Textbooks and Reference books:

1. Alberts, B. et al. Molecular Biology of the Cell (6th Ed.). New York: Garland Science.
2. Lodish, H. F. et al. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.

BITG401C16-17D: Molecular Endocrinology and Endocrinopathies

Unit I: Principles of Endocrinology

Autocrine, Paracrine and Endocrine system; Endocrine glands and histology, classification of hormones, characteristics, synthesis and transport of hormones.

Unit II: Hormones as messengers

Hormones and cell signaling. Extracellular and intracellular receptors, receptor ligand interactions, nuclear binding, co-activators and co-repressors. Receptor regulation and degradation.

Unit III: Peptide hormones and Endocrinopathies of Diabetes Mellitus

Eukaryotic metabolic regulation by Thyroid and Pancreatic hormones. Regulation of gene expression by cell surface receptors. Defects in receptors, G-proteins and clinical manifestation (e.g. diabetes mellitus)

Unit IV: Reproductive Endocrinology

Histology and function of primary (testis and ovaries) and accessory sex organs. Spermatogenesis, oogenesis, hypothalamic control and abnormalities of male and female sexual function. Reproductive hormones and their functions. Menstrual cycle and its regulation.

Unit V: Steroid hormones and Endocrinopathies of Polycystic Ovarian Syndrome

Mechanism of action of steroid hormones and Nuclear Receptor Superfamily. Nuclear Receptors in Endocrinology and Elimination of Xenobiotics. Interaction with DNA-post transcription and post translational effects, Ligand-independent transcriptional activation of steroid hormone receptors. Selective steroid receptor modulators and endocrine disruptors, Molecular basis of polycystic ovarian syndrome and management.

Unit VI: Molecular basis of Endocrine-related cancers

Prostate, ovarian and breast cancer. Clinical uses of steroid hormones and receptors.

Recommended Textbooks and Reference books:

1. Guyton and Hall. Textbook of Medical Physiology. 13th Edition.
2. Human Physiology by C.C. Chatterjee.
3. William's Text Book of Endocrinology Larsen et al.: An Imprint of Elsevier.
4. Endocrinology, Mac E. Hadley, Pearson Education.
5. Endocrinology. Vols.I, II and III by L.O. DeGroot. W.B. Saunders Co.
6. Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
7. The Nuclear Receptor Superfamily: Methods and Protocols (Methods in Molecular Biology) By Iain J. McEwan Publisher: Humana Press (Nov 19, 2010)

BITG401C16-17E: Pharmaceutical Biotechnology & Drug Design

Unit I. Pharmaceutical Biotechnology

Biotechnology in the Pharmaceutical Industry (Pre- and post-biotechnology products, biologics and pharmaceuticals); Fermentation products in pharmaceutical industries; Antibodies, Therapeutic Proteins, Vitamins, Amino acids, Monoclonal Antibodies.

Unit II. Basic Principles of Drug Discovery and Development

The Drug Discovery Roadmap; Identification of druggable target; Hit to Lead Process in Drug Discovery; High-throughput screening; Lead optimization; Bioanalytical assay development; Preclinical evaluation: Pharmacokinetics, Pharmacodynamics and toxicity assessment. Application of different imaging tools in modern drug discovery.

Unit III: Computer Aided Drug Design (CADD)

Structure-based drug design (SBDD) and Ligand-based drug design (LBDD); Docking and pharmacophore modelling; Application of quantitative structure-activity relationship (QSAR) and artificial intelligence (AI) in drug discovery.

Unit IV. Biopharmaceutics and Pharmacokinetics

Absorption, Distribution, Metabolism, and Excretion (ADME) principles; Bioavailability and Bioequivalence; Pharmacokinetics parameters - K_E, $t_{1/2}$, V_d, AUC, K_a, Cl_t and CL_R; Compartment and non-compartment models; First order, zero order and Nonlinear Elimination Kinetics; BCS classification of drugs; Routes of drug administration; Drug Delivery Systems; Drug dosage forms, Pre-formulation, and Formulation; Prodrug Approach in Drug Design.

Unit V: Synthesis and Pharmacology of some essential drugs

Who model List of Essential Medicines and National List of Essential Medicines (NLEM); Synthesis strategy of Analgesic, Antipyretic, Anti-inflammatory, Antibiotic, Antifungal and Antiviral agents. Clinical pharmacology of representative β-Lactam antibiotics, Analgesics agents, Antipyretic agents, Nonsteroidal Anti-inflammatory drugs (NSAID), GERD medicines, Hypertension drugs, Antineoplastic agents and Antiretroviral drugs.

Unit VI: Pharmaceutical Product Development and Drug Regulatory Affairs

Principles and applications of new product development in pharmaceutical industry; Six Sigma Concept; Phases of Clinical Trials; Quality Assurance (QA): GLP, GMP, GCP; Regulatory issues pertaining to commercialization of new drug entities: NDA, ANDA and BLA applications, post-marketing surveillance and FDA Adverse Event Reporting System (FAERS). Pharmacovigilance system in India: From an industrial perspective.

Recommended Textbooks and Reference books:

1. Michael J. Groves 2019 Pharmaceutical Biotechnology (2nd Edition) CRC Press
2. Krogsgaard-Larsen et al. 2016 Textbook of Drug Design and Discovery (5th Edition). CRC Press.
3. Neelina H. Malsch 2005. Biomedical Nanotechnology. CRC Press
4. Malcolm Rowland and Thomas N. Tozer. 2020. Clinical Pharmacokinetics and Pharamacodynamics: Concepts and Applications (SAE)
5. Dr. V. M. Kulkarni and Dr. K. G. Bothara. 2016. Drug Design, (7th Edition). Nirali Prakashan

BITG441C18: Research Journal Presentation (Credit: 4)

Students will learn to read, understand, discuss and present recent research articles in biomedical sciences or biotechnology during the weekly departmental seminar.

BITG442C19: Research Dissertation (Credit: 4)

As part of a research laboratory, students will be engaged in understanding the research question of that lab, will learn the major techniques that may be employed and will prepare a research proposal for his/her dissertation. The written proposal and a presentation to defend that proposal will be evaluated.

SEMESTER VIII

BITG451C20: One of the following - BITG401C20-21A/ BITG401C20-21B/ BITG401C16-17C/ BITG401C20-21D/ BITG401C20-21E

Credit: 4 (Theory: Credit- 4; Contact hours per week: 4 h; Total credit hour: 64 h)

BITG452C21: One of the following - BITG401C20-21A/ BITG401C20-21B/ BITG401C16-17C/ BITG401C20-21D/ BITG401C20-21E

Credit: 4 (Theory: Credit- 4; Contact hours per week: 4 h; Total credit hour: 64 h)

BITG401C20-21A: Medical and Molecular Virology

Unit I: Introduction to medical and molecular virology

Virus cell interaction - viral receptors, mechanisms of virus entry, uncoating and different strategies of viral replication. Host cell response to viral infections, cellular transformation and cytopathic effects. Mechanisms of viral persistence and latency-*in vivo* and *in vitro* models.

Unit II: Enteric virus diseases

Epidemiology of enteric viral diseases at National and International levels; enteric viral infections- Clinical course, disease burden, risk factors, prevention, and treatment. Rotavirus diversity, emerging strains, immunopathogenesis and vaccines. Other viruses associated with diarrhea and gastroenteritis.

Unit III: Respiratory and Hepatic virus diseases

Epidemiology of different respiratory and hepatic viral diseases at National and International levels; History, clinical features, epidemiology of influenza and other respiratory diseases; Biology and pathogenesis of Coronaviruses and human rhinovirus. Pathogenesis of different hepatitis viruses. Differential diagnosis and vaccines against viral hepatic and respiratory diseases.

Unit IV: Virus haemorrhagic fever and AIDS

Epidemiology of virus hemorrhagic fever and retroviral diseases at National and International level; Common clinical features of Viral Hemorrhagic Fevers, history and Disease burden, risk factors, replication strategy, pathogenesis, prevention and treatment of Dengue, Yellow Fever, Kyasanur forest disease, Chikungunya, Ebola. Introduction to retroviruses; Origin of HIV-1, HIV-2, SIV, immunopathogenesis, diagnosis and prevention.

Unit V: Oncogenic viruses

History of oncogenic viruses, viral oncogenesis, impact of oncogenic viruses in understanding cancer biology, cell transformation, discovery of proto-oncogene, oncogene and tumor suppressor genes.

Unit VI: Viral Encephalitis

Viral encephalopathy and meningitis clinical symptoms and causative agents, treatment modalities, Transmission and spread of the disease, diagnosis. Structure, genome organization, diversity, life cycle

and encephalopathies caused by Japanese encephalitis, West Nile virus, Chandipura virus, measles virus, Nipah virus and herpes virus. Routes and modalities of infections of the nervous tissue, blood brain barrier.

Recommended Textbooks and Reference books:

1. Fields Virology, 4th Ed., Vol 2 Ed by David M Knipe, and Peter M Howley
2. Viruses, Cell Transformation, and Cancer. Edited by J.A. Grand. Elsevier Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman , Uk Isa K. Mushahwar. 2001.
3. Perspectives In Medical Virology. Series Editor: Arie J. Zuckerman , Uk Isa K. Mushahwar. Elsevier.
4. Clinical Virology, Editors: Richman DD, Whitley RJ, Hayden FG,. ASM Press, 4th Edition.
5. HIV and Aids by Michael A. Palladino, David Wessner. Publisher: Benjamin Cummings
6. Viral Encephalitis in Humans. John Booss, Margaret M. Esin, Margaret Esiri (Editor). ASM Press.
7. Principles of Virology by J Flint, V Racaniello, G Rall, A M Skalka, 5th Edition.

BITG401C20-21B: Medical Biotechnology

Unit I: Gene Therapy

Conventional vs newer approaches, CRISPR-Cas9, antisense oligos, triple helix forming nucleotides, PROTACs, Ribozymes, Gene Delivery Methods, Viral Delivery, Models, Commercialization

Unit II: Vaccine technologies and other therapeutic applications

DNA based vaccines, mRNA-based vaccines, Peptide mimetics, Antisense therapeutics, Synthetic DNAs, Monoclonal antibody therapy and antibody engineering, Drug Delivery techniques

Unit III: Molecular Pharming and transgenic animals

Biopharmaceuticals, Transgenic animals, Drug designing, Pharmacogenomics, Nanomedicines, Stem cell therapy, Artificial Organs and Biomimetics

Unit IV: Molecular Diagnostics

Biosensors in Clinical Diagnosis, Analysis of minimal residual diseases (MRDs), use of microfluidics, Lab-on-a-chip, Forensic and DNA Profiling, Satellite DNA, Population Genetics and Allele, Single and Multi-locus VNTRs, Digital DNA typing, Frye test, Next-Generation Sequencing in Clinical Molecular Diagnostics, DNA Databases.

Recommended Textbooks and Reference books:

1. Medical Biotechnology (2013) 1st ed., Glick BR, Patten CL, Delovitch TL, Bernard R. Glick, Cheryl L. Patten, Terry L. Delovitch., ASM Press
2. Medical Biotechnology (2011) 1st ed., Tayal DC., Himalaya Publishing House
3. Textbook of Pharmaceutical Biotechnology (2021) 1st ed., kokate C. Jalalpure SS, Hurakadle PJ. CBS Publishers
4. Medical Biotechnology (2017) 1st ed., Jogdand SN. Himalaya Publishing House.

BITG401C20-21C: Neurobiology of Disease

Unit I: Development and organization of nervous system (cellular neurobiology)
Cells of the nervous system; Synapse and synaptic transmission, Processing of neural signal in the sensory system, Somatic and autonomic nervous system; Neuromuscular junctions; Meninges and cerebrospinal fluid; Blood Brain Barrier; Blood-CSF barrier, neural stem cells

Unit II: Neuroplasticity, physiology and behavior
Neurotransmitters and neuropeptides; Ion Channels, receptors and energy Metabolism. Transport, protein trafficking and signal transduction; Resting Potential & Action potential; LTP and LTD and protein synthesis Degeneration & regeneration of nerves; Synaptic & neuro-muscular transmission; Synaptic plasticity; Learning and memory: types and molecular basis; Memory consolidation.

Unit III: Diseases of the Nervous System
Autism spectrum disorder; ADHD; Learning & Memory disorders; Epilepsy; Traumatic brain injury, Alzheimer's disease, Parkinson's disease, Addiction, Stroke and cerebral infarctions, Anxiety and depression.

Unit IV: Neuro-immune interactions and disorders
Immune cells in the brain; Interaction between peripheral immunity and central nervous system; Neuro-Pathogens and host interactions; Prions; Autoimmune disorders; Encephalomyelities; Psychoneuroimmunology; Neuro-immunomodulation

Unit V: Tools and Technologies for diagnosis and treatment
Stem cell culture, slice cultures and organoids; Allen Brain Atlas, Single neuron recording, Neuroimaging-CT, MRI, Mylography; PET Single -Photon Emission Computed Tomography, MR Spectroscopy; fMRI Monitoring neural activity- Optogenetics, Chemogenetics; Magnetic stimulations; Deep brain stimulations; Testing motor and cognitive functions; MMSE scoring; Psychometric assessments; Artificial Intelligence for prediction of diseases.

Recommended Textbooks and Reference books:

1. Eric Kandel: Principles of Neural Science
2. Squire et al: Fundamental Neuroscience
3. Guyton and Hall: Text Book of Medical Physiology

BITG401C20-21D: Agricultural & Microbial Biotechnology

A. Agricultural Biotechnology
Unit I: Plant breeding techniques
Various steps in breeding a new genetic variety, Backcrossing, inbreeding, Cross breeding, Markers in Plant Breeding, markers assisted selection; QTL, Clonal selection, Heterosis. Mutation breeding. Male sterility (nuclear and cytoplasmic). Male sterility assisted hybrid vigor. Heritability. Plant breeding for crop improvement, Multi-gene pyramiding, Indian hybrid crops, modern plant breeding techniques, GMOs,

Field testing of transgenic plants-Prospects and perspectives. Germplasm conservation, Seed health certification system.

Unit II: **Greenhouse technology and protected cultivation**

Types, features, functions and importance of greenhouse. Planning, design criteria and calculation for greenhouse. Growing of ornamentals and vegetables, pest and disease control.

Unit III: Post Harvest Biotechnology of food grains and horticultural crops

Classification, chemical composition and nutritional values of food grains. Anti-nutritional factors, Food preservation and storage. Transgenes for altered composition of oil/ starch/ amino acid/vitamins/anti-nutrients. Pre- and Post-harvest factors affecting shelf life. Post-harvest technologies for ripening, fruit softening, flavor fragrance and senescence. Microbial contaminants and post-harvest pathology. Recycling Horticultural waste.

B. Microbial Biotechnology

Unit I: Microbial Biotechnology and its Applications

Scope and its applications in human therapeutics, artificial intelligence in Microbial Biotechnology, agriculture (Biofertilizers, PGPR, Mycorrhizae), Rhizosphere Engineering, environmental, and food technology. Biofilm and its ecological implication. Use microorganisms in biotechnological applications. Genetically engineered microbes for industrial application. Understanding microbial diversity using metagenomics. Prospecting genes of biotechnological importance using metagenomics. Basic knowledge of metatranscriptomics, metaproteomics and metabolomics

Unit II: Therapeutic and Industrial Biotechnology

Recombinant microbial production processes in pharmaceutical industries- Streptokinase, recombinant vaccines, recombinant protein production, microbial polysaccharides and polyesters, microbial production of bio-pesticides, bioplastics, microbial Biosensors. Microbial fermentation and fermented foods. Probiotics, prebiotics and synbiotics

Unit III: Applications of Microbes in Biotransformation

Microbial based transformation of steroids and sterols; Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute. Transformation of antibiotics, pesticides, pollutants, xenobiotic, petroleum (camphor, octane, xylene, and naphthalene) and polychlorinated biphenyl.

Unit IV: Microbes for Bio-energy and Environment

Different generations of Biofuel, Bio-ethanol and Bio-diesel production: commercial production from lignocellulosic waste and algal biomass. Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Concept and molecular mechanisms of bioremediation. Constraints and priorities of bioremediation. Bioaugmentation; ex-situ and in-situ processes; intrinsic and engineered

bioremediation. Methods of bioremediation: Bioleaching, phytostabilization, biosorption, biomineralization, bioaccumulation, biotransformation. Phycoremediation.

Recommended Textbooks and Reference books:

1. Genes I -IX by Lewin B. Oxford University Press , Oxford.
2. Fundamentals of Genetics by B.D. Singh, Kalyani Publishers.
3. Fundamentals of Genetics by Ringo, Kalyani Publishers.
4. Greenhouse Management of Horticultural Crops by S. Prasad and U. Kumar, Kalyani Publishers.
5. Greenhouse Technology and Management by Manohar. 2006. International Book Distribution Co.,
6. Food Biotechnology by Shetty, 2006, CRC,NY
7. Agrios, G.N. 2005. Plant Pathology – (5th Edition). Academic Press, New York.
8. Singh B.D, (2003), Biotechnology, Kalyani Publishers
9. R.C. Dubey (2009), A Textbook of Biotechnology, S Chand and Company, Ltd.
10. Willey J, Sandman K and Wood D (2023) Prescott's Microbiology. 12th Ed. McGraw Hill International.
11. Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA (2020) Brock Biology of Microorganisms, 16th ed. Published by Pearson

BITG401C20-21E: Regenerative Medicine

Unit I: Stem cells

Stem cells in organ maintenance and injury repair, Pluripotent Stem Cells: embryo and induced; Mesenchymal stem cells for tissue regeneration - Introduction, MSC sources and phenotype, Differentiation of MSc *in vitro*

Unit II: Stem cells and wound repair

Clinical burden of wound repair, Physiology of wound healing, Current treatment strategies for wound healing; Tissue engineered skin substitute - matrix based products & cell based products, Stem cells and wound repair

Unit III: Skeletal tissue engineering: Lessons learned from endogenous skeletal tissue development, healing, and regeneration Progenitor cell-based bone & cartilage tissue engineering, Hydrogels for directed differentiation of mesenchymal stem cells, Advances in skeletal tissue engineering scaffolds, Decellularized materials for skeletal tissue regeneration

Unit IV: Stem cells, organoids, and disease modeling

Stem cells culture, Introduction to different cell types and organoids, Characterization of stem cells & Stem cell-derived organoids, Cell reprogramming and editing, Stem cell diseases and personalized medicine, Ageing and Stem Cells, Organoids as therapeutic tools, Future in stem cells and organoids models, neural regeneration in models of traumatic brain injury

Unit V: Cancer stem cells and improving the pharmaceutical model: The theory and concept of cancer stem cell, Cancer Spheroid model, Targeting approach against cancer stem cells.

Recommended Textbooks and Reference books:

1. Principles of Regenerative Medicine by Anthony Atala, James A. Thomson, Robert Lanza, Robert Nerem, Elsevier Science.
2. Tissue Engineering and Regenerative Medicine by Phuc Van Pham Springer International Publishing
3. Emerging technology platform for stem cells, edited by Uma Lakshmipathy, Jonathan D. Chesnut. Publisher: John Wiley & sons Ltd, 2009.
4. Stem cell Research: Medical application & Ethical controversy, Joseph Panno, The New Biology, 2005
5. Organoids, Stem Cells, Structure, and Function, Kursad Turksen, Editors: Springer Link 2019
6. The Global politics of human embryonic stem cell science: Regenerative medicine transition, By Herbert Gottwels, Brain Salter and Catherine Waldby, Publisher: Palgrave Mac Milan, 2009.

BITG491C22: Research Grant Writing (Credit: 4)

Preparation of a hypothesis-driven research proposal on biomedical/biotechnical science, which should include a brief literature review, origin of proposal, significance and potential impact of the proposed research on ongoing scientific advancement, experimental design, pitfalls and alternative strategies (following the SERB format for three years of research funding); Both the written proposal, and an oral presentation with logical framework of the proposed research will be assessed

BITG492C23: Research Dissertation (Credit: 8)

As part of a research laboratory where one student started his/her dissertation in the previous semester, he/she will continue to work on the proposed research (BITG441C19), following standard laboratory protocols, and related techniques. He/she will perform data collection, data analysis, and ethical aspects of research. A written dissertation, and an oral presentation on the project outcome will be assessed.

Skill Enhancement Courses (SEC1 and 2)

(*Offered to the students of Biotechnology***)**

SEMESTER III

BITG203SEC01: Bioethics & Biosafety in Biotechnology

Credit: 4 (Theory- 3, Practical- 1)

Theory (Credit: 3; Contact hours per week: 2 h; Total credit hour: 32 h)

A. Bioethics

Overview of research misconduct, rules and regulations in India; data management; privacy policies, institutional and professional code of ethics and standards of practice

Ethical use of bioresources- agricultural ethics and transgenic crops, animal subjects; Protection of human subjects; stem cell ethics; eco sourcing-code of practice

Mentor-mentee responsibilities; Collaboration, Bias, Conflicts of Interest; Publication- plagiarism

Cyber Security Awareness; understanding phishing attacks, malware, antivirus software.

B. Biosafety

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, Safety measurement for radioactive material; Social responsibility and Whistleblowing

Practical (Credit: 1; Contact hours per week: 2 h; Total credit hour: 32 h)

1. Planning of establishing a hypothetical biotechnology industry in India
2. A case study on clinical trials of drugs in India with emphasis on ethical issues
3. Demonstration of biosafety and chemical safety
2. Use of PPE
3. A case study on lab safety
4. A case study on radiation safety

Recommended Textbooks and Referencing books:

1. Rajmohon Joshi. Biosafety and Bioethics. Isha Books.
2. IPR, Biosafety And Bioethics 2013, Goel, Pearson
3. Bioethics and Biosafety in Biotechnology, V. Shree Krishna, New Age International Publishers

SEMESTER IV

BITG253SEC02: Analytical Techniques in Biotechnology

Credit: 5 (Theory- 4, Practical- 1)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Centrifugation techniques

Principle of centrifugation, different types of centrifuges, Ultracentrifugation; Differential & density gradient centrifugation. Isolation of subcellular organelles using cell fractionation technique.

Unit II: Basic spectrophotometry

Principle and law of absorption, colorimetry, spectrophotometry (visible, UV, infrared).

Unit III: Introduction to electrophoresis

Starch-gel, polyacrylamide gel (native and SDS-PAGE), Agarose gel electrophoresis, pulse field gel electrophoresis, Blotting techniques (southern, northern, western and eastern) 2D-gel electrophoresis, DIGE.

Unit IV: Bio-separation techniques

Filtration and Dialysis. Principles of protein purification. Various column chromatography techniques - Size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, Hydrophobic interaction and Reverse-Phase chromatography. HPLC, FPLC, Gas chromatography.

Practical (Credit: 1; Contact hours per week: 2 h; Total credit hour: 32 h)

1. Ammonium sulphate fractionation of a protein and dialysis
2. Spectroscopic experiment with protein/DNA/RNA
3. Purification of a recombinant protein by affinity chromatography
4. Fractionation of proteins by ion-exchange chromatography

Recommended Textbooks and Reference books:

1. David Sheehan. Physical Biochemistry (2nd ed)
2. David Freifelder. Physical Biochemistry: Applications to Biochemistry and Molecular Biology
2. John M. Walker (editor). The Protein Protocols Handbook (2nd ed). Springer

Value Added Courses (VAC1 and 2)

(*Offered to all students of Science Stream of Presidency University***)**

SEMESTER III

ENVS204VAC01: Environmental Science

Credit: 3 (Theory- 3; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I: Introduction to environmental studies: Multidisciplinary nature of environmental studies; Scope and Importance; Concept of sustainability and sustainable development.

Unit II: Ecosystems

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit III: Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: in-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Pollution

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Pollution case studies.

Unit V: Environmental Policies & Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

Unit VI: Human Communities and the Environment

Human population growth: Impacts on environment, human health and welfare. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

Recommended Textbooks and Reference books:

1. Silent Spring (2005) 40th ed., Carlson R., Mariner Books Classics.

2. Fundamentals of Ecology (2017) 5th ed., Odum E., Cengage India Private Limited
3. Environmental and Pollution Science (2019) 3rd ed., Brusseau ML, Pepper IL, Gerba C., Aca. Press.
4. Environmental law and policy in India (2002) 2nd ed., Shyam D, Armin R., Oxford India.
5. Ecology and economics: An approach to sustainable development (2002) Sengupta R. Oxford India.
6. Ecology, Environmental Science and Conservation (2017) 1st ed., Singh JS, Singh SP, Gupta SR., S. Chand Publishing, New Delhi.
7. Conservation Biology: Voices from the Tropics (2013) Sodhi NS, Gibson L, Raven PH., Wiley-Blackwell.

SEMESTER IV

BITG291VAC02: Clinical Biochemistry

Credit: 3 (Theory: 3; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I: Overview of Clinical Biochemistry

Introduction to Clinical Biochemistry: Importance, Scope, Relevance and Current scenario; Acquaintance with Clinical Biochemistry Laboratory Set-up: Instruments, Reagents, Controls and Calibrators; Preparation of patients for sample collection: precautionary measures, acceptance and rejection of samples for analysis

Unit II: Clinically important enzymes and related pathophysiology

Enzymes of clinical significance-Creatine Kinase, Lactate Dehydrogenase, Aspartate Aminotransferase, Alanine Aminotransferase, Alkaline Phosphatase, Acid Phosphatase, Glutamyl transferase, Amylase, Lipase, Glucose-6-Phosphate Dehydrogenase, Drug-Metabolizing Enzymes; Tumor markers, Bone markers, Cardiac markers, liver markers; Inborn errors of metabolism- Glycogen storage diseases, Fructosuria, Fructose intolerance, Pentosuria, Galactosuria, Urine screening; Inborn errors associated with carbohydrate metabolism.

Unit III: Quality management in clinical biochemistry

Categorisation and Identification of Laboratory errors: pre-analytical, analytical and post-analytical; Steps to minimize laboratory errors viz; Pre-analytical, analytical and post-analytical; Various interfering substances in biochemical results and interpretation of test results thereof; Concepts of Quality Management in a Clinical Biochemistry Laboratory: Internal Quality Control (IQC) & External Quality Control (EQC) etc.; Proper Reporting of Biochemical Results: Laboratory Informatics: Computing fundamentals, Laboratory reporting systems like LIS, HIMS etc. and Information System Security

Recommended Textbooks and Reference books:

1. Michael L. Bishop, Edward P. Fody and Larry E. Schoeff; (2013). Basic Principles and Practice of Clinical Chemistry, (7th Ed). Lippincott Williams and Wilkins.
2. Stryer, L. (2002). Biochemistry, (8th Ed). Freeman.
3. D.M. Vasudevan and Sreekumari, S, (2010). Textbook of Biochemistry for Medical Students, (6th Ed). Jaypee Brothers Medical Publishers, New Delhi.
4. Sucheta Dandekar; (2010). Concise Medical Biochemistry, (3rd ed), Elsevier Health.

Minor Courses

(*MC1-4 are offered to all students of allied science subjects of Presidency University, MC5-6 are offered to the students of Biotechnology***)**

SEMESTER I

BITG104MC01: Chemistry-1

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. General and Physical Chemistry

Unit I: First Law of Thermodynamics and Chemical Energetics

Calculation of work (w), heat (q), changes in internal energy (ΔE) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w, q, ΔE, and ΔH for processes involving changes in states; Thermochemistry, Concept of standard state and standard enthalpies of reactions. Calculation of bond energy, Bond dissociation energy and Resonance energy from thermochemical data; Kirchhoff's equation.

Unit II: Second Law of Thermodynamics

Concept of entropy, Gibbs free energy and Helmholtz free energy. Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity, Gibbs Helmholtz equation. Maxwell's relations. Statement and qualitative description of Third Law of thermodynamics.

Unit III: Chemical Equilibrium

Free energy changes in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gas.

Unit IV: Chemical Kinetics

Activation energy and transition-state theory; Different orders of chemical reactions, free energy and chemical reaction. Catalysts and Enzymes. Ideas of theories of reaction rates.

B. Inorganic Chemistry

Unit I: Atomic Structure

Bohr's theory, atomic spectra of hydrogen, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many- electron atoms, Aufbau principle and its limitations.

Unit II: Chemical Bonding

Covalent, electrovalent, Coordination and hydrogen bonding, polarizing power, and polarizability, Fajan's rules, dipole moments, Lattice energy and solvation energy, VSEPR theory, Valence bond theory (VBT), concept of hybridization, molecular orbital theory (MOT), Coordination chemistry.

C. Fundamentals of Organic Chemistry

Hybridization in organic compounds, cleavage of covalent bond, homolysis and heterolysis, Electronic effects: inductive effect, mesomeric effect, resonance and hyperconjugation. Structure and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions, free radicals and carbenes. Strength of organic acids and bases, Aromaticity, molecular forces.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator
4. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide

Recommended Textbooks and Reference books:

1. Lee, J. D. Concise Inorganic Chemistry, ELBS (1991).
2. Dutta, R. L. & De, G. S. Inorganic Chemistry (Vol. 1), The New Book Stall (1973).
3. Sarkar, R. P. General and Inorganic Chemistry (Vol. 1), 3rd Ed., New Central Book Agency (2011).
4. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, (1988).
5. Graham Solomons, T. W.; Fryhle, C. B. & Snyder, S. A. Organic Chemistry, John Wiley & Sons (2017).
6. Finar, I. L. Organic Chemistry (Vol. I), 6th Ed., Pearson (2002).
7. Castellan, G. W. *Physical Chemistry,* 4th Ed., Narosa (2004).

SEMESTER II

BITG154MC02: Chemistry-2

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

A. Physical Chemistry

Unit I: Ionic Equilibrium

Strong, moderate, and weak electrolytes, degree of ionization, factors affecting degree of ionization. Unique properties of water, weak interactions in aqueous systems, ionization of water. Ionization of weak acids and bases, pH scale, Common ion effect. Buffer solutions. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Solubility product of sparingly soluble salts. Maintenance of blood pH. Water as a reactant and fitness of the aqueous environment.

Unit II: Phase Equilibrium

Phases, components, and degrees of freedom of a system, criteria of phase equilibrium. Gibbs phase rule and its thermodynamic derivation, Clausius-Clapeyron equation and its importance in phase equilibria. Phase diagrams.

Unit III: Surface Tension and Viscosity

Surface tension and Viscosity of a liquid and their determination; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only); Physical adsorption, chemisorption, adsorption isotherms.

B. Stereochemistry

Geometrical isomerism, cis-trans and E/Z nomenclature. Optical isomerism-optical activity, plane polarized light, chirality, specific molar rotation, Homomers, Enantiomers, Diastereomers; Projection diagrams of stereoisomers: Fischer, Newman and Sawhorse projections. Configuration: D/L designation, R/S designation of chiral centers.

C. Organic chemistry

Unit I: Reaction Mechanisms

Substitution: Aliphatic nucleophilic Substitution: SN1, SN2 and SNi; Aromatic electrophilic substitution and nucleophilic substitution; Elimination: Elementary idea to E1, E2-eliminations, E1CB, Saytzeff and Hofmann rule; Addition: Electrophilic addition, Markownikov's and anti-Markovnikov's rule, nucleophilic additions; Radical reactions: Halogenation; Stereochemical features of reaction mechanisms.

Unit II: Important Organic Reactions

Oxidation reactions: OsO_4, $K_2Cr_2O_7$, alkaline KMnO4, PCC/PDC etc.; Reduction reactions: Catalytic hydrogenation, $NaBH_4$, $LiAlH_4$ etc.; Rearrangements: Neopentyl rearrangement, Arndt Eistert rearrangement etc.; Aldol condensation, Cannizzaro reaction, Wittig reaction, Benzoin condensation, Esterification, Ester hydrolysis, Preparation of acid derivatives and their interconversion, Hofmann Degradation.

Unit III: Identification of Functional Groups

Alkenes, Alkynes, Alkyl/Aryl Halides, Alcohols, Phenols, Ethers, Aldehydes, Ketones, Carboxylic acids and its derivatives, Nitro group, Amines and Diazonium Salts.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Separation of mixtures by Chromatography: Measurement of R_f value in each case (combination of two compounds to be given)-

(a) Separate and identify the aromatic compounds in a given mixture by Thin Layer Chromatography
(b) Separate and identify the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine, or any other amino acid) by paper chromatography.
(c) Separate and identify the sugars present in a given mixture by paper chromatography.

2. Preparation and measurement of pH of buffer solution: (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide.
3. Preparations of organic molecules, recrystallisation, determination of melting point and calculation of quantitative yields.

Recommended Textbooks and Reference books:

1. Eliel, E. L. Stereochemistry of Carbon Compounds, Tata McGraw Hill Education (2000).
2. Subrata Sen Gupta, Basic Stereochemistry of Organic Molecules, Oxford University Press (2018).
3. Organic Chemistry: Subrata Sen Gupta, Oxford.
4. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
5. Subhas C. Das, Advanced Practical Chemistry, The World Press Pvt. Ltd. Sixth Edition.
6. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry Orient-Longman (1960).
7. Vogel, A. I.; Tatchell, A. R.; Furnis, B. S.; Hannaford, A. J. & Smith, P. W. G. Textbook of Practical Organic Chemistry, 5th Ed., Prentice-Hall (1996).

SEMESTER III

BITG205MC03: Computational & Statistical Methods-1

Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Introduction to Biostatistics

Principles and practice of statistical methods in biology**;** Samples and populations**;** Data collection and graphical representation**;** Measures of central tendency- mean, median, mode**;** Measures of dispersion- range, mean deviation, coefficient of variation**;** standard deviation, standard error**;** Measures of skewness and Kurtosis.

Unit II: Probability and probability distributions

Basic concepts of probability**;** Bayes theorem**;** Binomial, Poisson, and Gaussian distribution**;** Sampling distribution and central limit theorem.

Unit III: Hypothesis testing

Null Hypothesis**;** Level of significance**;** Error of interference**;** One-sample and Two-Sample tests of hypothesis (Use of z-test and t-test).

Unit IV: Correlation and Regression

Correlation (Pearson's r, Spearman Rank)**;** Regression (Simple, Multiple, Logistic).

Unit V: Non-parametric tests and Analysis of Variance

Chi-square test**;** Kruskal-Wallis test**;** ANOVA**;** Post-hoc tests for multiple sample analysis.

Unit VI: Introductory data mining techniques in advanced statistics/machine learning
Dimensionality reduction (Principal Component Analysis)**;** Data Normalization (RPKM, TPM, DeSeq2)**;** Data Transformation (Log, Square root)**;** Clustering (k-means, Hierarchical).

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. Introduction to statistical programming with R - I
2. Introduction to statistical programming with R - II
3. Introduction to data visualization
4. Hypothesis testing of different statistical methods using biological data - I
5. Hypothesis testing of different statistical methods using biological data - II
6. Organization of high throughput sequencing data - PCA, clustering
7. Visualization strategies for high throughput sequencing data - heatmap, volcano plot

Recommended Textbooks and Reference books:

1. Le, Chap T. Introductory biostatistics. John Wiley & Sons, 2003.
2. Glaser, Anthony N. High-yield biostatistics. Lippincott Williams & Wilkins, 2005.
3. Edmondson, Andrew, and David Druce. Advanced biology statistics. Oxford University Press, 1996.
4. Daniel, Wayne W., and C. L. Cross. Biostatistics: A foundation for analysis in the health sciences. John Wiley & Sons. Inc., 1995.
5. Elston, Robert C., and William Johnson. Basic biostatistics for geneticists and epidemiologists: A practical approach. John Wiley & Sons, 2008.
6. Hartvigsen, Gregg. A primer in biological data analysis and visualization using R. Columbia University Press, 2021.

SEMESTER IV

BITG255MC04: Computational & Statistical Methods-2
Credit: 6 (Theory- 4, Practical- 2)

Theory (Credit: 4; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Introduction to Biological Databases
Collection, organization, storage, and retrieval of data**;** Sequence databases**;** Gene Expression databases**;** Structural databases**;** Database search strategies.

Unit II: Sequence Analysis
Concept of homology and definition of associated terms**;** Pairwise sequence alignment: dynamic programming algorithm, global and local alignments**;** BLAST Scoring matrices, gap penalty, statistical significance of alignment**;** Multiple sequence alignment: progressive alignment, iterative alignment, Sum-

of-pairs method, CLUSTAL W**;** Pattern recognition and repeat finding in protein and DNA sequences, Hidden Markov Model, Profile construction and searching, PSI-BLAST.

Unit III: Phylogenetics and Comparative Genomics

Concept of phylogenetics using maximum parsimony method, distance method, maximum-likelihood method**;** Gene prediction in prokaryotes and eukaryotes, homology and ab-initio methods**;** Genome analysis and annotation**;** Comparative genomics.

Unit IV: Structural Biology

Protein secondary structure elucidation using peptide bond, torsion angles, Ramachandran plot**;** Protein secondary structure prediction**;** Fundamentals of the methods for protein 3D structure prediction**;** Homology Modeling**;** Fold recognition, threading and ab-initio structure prediction methods. Molecular docking, Protein-protein interaction study, simulation; String analysis, Metabolic network prediction.

Unit V: Big data analysis

Introduction to next-generation sequencing data and analysis strategies.

Practical (Credit: 2; Contact hours per week: 4 h; Total credit hour: 64 h)

1. General file formats used in biological databases, Linux commands to retrieve, upload, & operate data.
2. Retrieving information from generalized databases: Nucleotide (gene, genome) and protein sequence data from NCBI database, Structural information of proteins using PDB database
3. Retrieving information from specialized databases: ENCODE, HMP, TCGA/cBioPortal
4. Using BLAST for similarity searching of DNAs and proteins in reference databases
5. Creating multiple sequence alignments from homologous DNA and protein sequences and identification of conserved motifs
6. Using phylogenetic analysis to delineate the source and evolution of viruses.
7. Protein homology modeling for predicting 3D structures from amino acid sequences.
8. 16S rRNA amplicon-based Next Generation Sequencing data analyses

Recommended Textbooks and Reference books:

1. Zvelebil, Marketa, and Jeremy O. Baum. Understanding Bioinformatics. Garland Science, 2007.
2. Lesk, A. M. Introduction to Bioinformatics. Oxford University Press. 2002.
3. Xiong, Jin. Essential bioinformatics. Cambridge University Press, 2006.
4. Choudhuri, Supratim. Bioinformatics for beginners: genes, genomes, molecular evolution, databases and analytical tools. Elsevier, 2014.
5. Gu, Jenny, and Philip E. Bourne, eds. Structural Bioinformatics. John Wiley & Sons, 2009.
6. Wang, Xinkun. Next-generation sequencing data analysis. CRC Press, 2023.

SEMESTER VII

BITG443MC05: Research Methodology

Credit 4; (**Theory**; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: **Foundations of Research**

Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory; Characteristics of scientific method. Understanding the language of research- concept, construct, definition, variable research process

Unit II: Problem Identification & Formulation

Research question, Investigation question; Measurement issues; Hypothesis – qualities of a good hypothesis- Null hypothesis & Alternative hypothesis, Hypothesis testing – logic & importance

Unit III: Research Design

Concept and importance in research – Features of a good research design – Exploratory research design – concept, types and uses, Descriptive research designs – concept, types and uses. Experimental Design: Concept of independent & Dependent variables

Unit IV: Qualitative and Quantitative Research

Concept of measurement, causality, generalization, replication. Merging the two approaches.

Unit V: Measurement

Measurement: Concept of measurement– what is measured? Problems in measurement in research – validity and reliability. Levels of measurement – Nominal, ordinal, interval, ratio.

Unit VI: Sampling

Concepts of statistical population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample– Practical considerations in sampling and sample size.

Unit VII: Data Analysis

Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

Unit VIII: Interpretation of Data and Paper Writing

Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit IX: Use of tools / techniques for Research

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer science discipline. Use of methods to search required information effectively, Reference Management Software like Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Recommended Textbooks and Reference books:

1. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R. Kothari

SEMESTER VIII

BITG493MC06: Research and Publication Ethics

Credit 4 (**Theory**; Contact hours per week: 4 h; Total credit hour: 64 h)

Unit I: Philosophy and Ethics

Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgement and reactions

Unit II: Scientific Conduct

Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: falsification, fabrication and plagiarism, Redundant publications: duplication and overlapping publications, salami slicing, Selective reporting, and misinterpretation of data.

Unit III: Publication ethics

Publication ethics- definition, introduction and importance, best practices/standards setting initiatives and guidelines: COPE, WAME etc; Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals; Predatory publishers and journals.

Unit IV: Open Access Publishing

Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester etc

Unit V: Publication Misconduct

Group discussion on Subject specific ethical issues, FFP, authorship; Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad, Hands on training to use of plagiarism software like Turnitin, Urkund and other open-source software tools

Unit VI: Databases and Research Matrices

Analyzing various Databases-Indexing databases; Citation databases: Web of Science, Scopus etc . Use of Software tools to analyze Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Citescore; Analyzing Metrices- h-index, g index, i10 index, altmetrics.

Recommended Textbooks and Reference books:

1. Handbook of Research and Publication Ethics. Nimit Chowdhary and Sarah Hussain (Editor)
2. Research and Publication Ethics. Singh UP., Ahlawat S. and Sharma S. Sultan Chand & Sons pub.

Multi-Disciplinary Courses

(*MDC1-3 are offered to all students of Presidency University)*

SEMESTER I

BITG141MDC01A: Science for Human Welfare

Credit: 3 (**Theory**; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I: Advancement in Industry- Protein engineering; enzyme and polysaccharide synthesis, activity and secretion; alcohol and antibiotic formation.

Unit II: Advancement in Agriculture, N2 fixation; transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

Unit III: Improvement in Environments- e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers

Unit IV: Advancement in Forensic science- solving crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA fingerprinting.

Unit V: Biomedical science and health- development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal antibody, human genome project.

Recommended Textbooks and Reference books:

1. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

BITG141MDC01B: Music for Mental Health

Credit: 3 (**Theory**; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I. The Science of Music

Cognitive Psychology and the Neuroscience of Musical Perception; How music impacts brain function, behaviour and brain development; Musical brains: How a musician differs from a nonmusician. Cognitive benefits of musical training; Music: Culture, Biology or both?

Unit II. Musical building blocks

Introduction to different elements of music like Pitch, Timbre, Tone, Microtones, Consonance, Dissonance, Musical Scales, Melody, Harmony, Rhythms, Beats, Intonation, Modulation, Improvisation, Ornamentation, Voice, and Aesthetics with reference to Indian Music.

Unit III. Music, emotion and well-being

Music Psychology: How music affects our mood and emotion; Healing with music: Western vs Traditional Indian Approaches. Multicultural considerations in music therapy; Effect of Indian Classical Music and ragas on mental health – demonstration and case studies.

Unit IV. How music can change our life

How music can – i) motivate the mind and promote academic achievement; ii) improve memory in children; iii) benefit Dementia and Alzheimer's patients; iii) improves social communication and auditory–motor connectivity in autistic children; iv) reduces pain in palliative care patients; v) improves sleep quality; and vi) help with addiction recovery. Case studies.

Unit V. Learn through hands-on activities how to live a healthier and happier life with music.

Introduction to Compositional, Improvisational, Receptive and Recreative Music Therapy. Demonstration of simple strategies and techniques to improve our quality of life: i) Stress management by listening to relaxing music, chanting, practicing deep breathing (pranayama), and musical progressive muscle relaxation (PMR) exercises; ii) Creating personalized playlists to suit different needs in our life; iii) Writing songs and composing personalized music for creativity, comfort and awakening; iv) Circle singing exercises; v) Lifting mood and energizing with group singing, playing and body percussion activities.

Recommended Textbooks and Reference books:

1. Dennis Plies, Lawrence Sherman, et al. 2023 Every Brain Needs Music: The Neuroscience of Making and Listening to Music
2. Henkjan Honing 2021 Music Cognition: The Basics
3. Rajam Shanker 2020 The Healing Power of Indian Ragas: Personal Experiences of Ragas applied in Music Therapy

SEMESTER II

BITG191MDC02A: Science Communication

Credit: 3 (**Theory**; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I. Introduction to Science Communication

The Importance of Scientific Outreach; Different modes of scientific communication - news article, editorial, scientific report, review article, original research article, thesis, poster, oral presentation in a conference, scientific art etc. Strategies for science communication; Role of diversity, equity, inclusion, and cultural awareness in Science Communication.

Unit II. Speaking of Science: Oral Presentation

Best practices for public speaking; Style and Content; How to understand and connect with your audience during live, recorded, and virtual presentations; Rules of great storytelling in science with reference to the most inspiring TED presenters. Scientific interviews; The art of explaining complex science topics to laymen, non-experts and policy-makers. The importance of body language and intonation during an oral presentation.

Unit III. Writing Science: Written communication

Conventions in academic scientific writing – tone, style, structure and choice of words; Assessing credibility of an information resource – facts versus opinions; Use of PUBMED, Google Scholar and other search engines to conduct a literature search; How to avoid plagiarism by summary writing, paraphrasing, using quotations (wherever relevant), appropriate citations, and using software for similarity and plagiarism checks; Scientific writing for general public vs expert audience; Science blogging: Creating a successful science blog.

Unit IV. Technology-based Science Communication

Science communication outside traditional written and oral communication: Different forms of educational technologies, computer games, and simulations. Social Media for Science Communication.

Unit V. Scientific Illustration, Animation, Photography, and Science Songs

The Arts as a Bridge in Sci-Com; Hands-on experience in designing scientific illustrations with pencil-sketch, painting, and digital tools; 3D-scientific visualization; Basics of 2D and 3d animation; Communicating science with science doodles, science comics, animated videos, and science songs.

Recommended Textbooks and Reference books:

1. Science In Public: Communication, Culture, And Credibility by Jane Gregory
2. Successful Science Communication: Telling It Like It Is by David J. Bennett

BITG191MDC02B: Survival Strategies of Living Things

Credit: 3 (**Theory**; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I: Evolution and survival

General concepts of evolution, Darwin - concepts of variation, Adaptation, Struggle, Fitness and natural selection, human evolution and cross-continental migration

Unit II: Survival strategies in microbes, plants and animals

Survival strategies in bacteria and parasites - evasion of host immunity, intracellular survival, biofilm formation, Quorum sensing, symbiosis and antagonism, toxins; Survival strategies in plants and animals, Colouration – Paulton's classification of animal's colour, types of colouration and pigments in animals; Mimicry – Batesian and Mullerian mimicry, aggressive or predatory mimicry, parasitic mimicry, mimicry in plants; Camouflage; Communication in animals – components and types of communication, Aggression – Moyer's classification of aggression, causes of aggression - endogenous and exogenous factors; structural and behavioral adaptations; Cooperations and conflicts – altruism, cooperative hunting

Unit III: Survival in extreme environments

Survival of plants and animals in extreme environmental conditions - Polar, Desert, High altitude, Deep Ocean , mechanisms, extremophiles and their molecular adaptations

Unit IV: **Invasive species**
Definition, Colautti and MacIsaac nomenclature, Invasive plant, animal and marine species, Ecological, social and economic impacts of invasive species, Evolution of invaders, predicting invasive species - Weed risk assessment model

Unit V: Climate change adaptation
Definition, Effects of climate change in humans, Aims of climate change adaptation, Climate resilience, Adaptation strategies and challenges.

Unit VI: Disaster and Disaster management
General perspective of Disaster, Global and Indian scenario, Importance of study in human life, Direct and indirect effects of disasters, Long term effects of disasters, Natural Disaster and Manmade disasters, Disaster Management, Policy and Administration, Preventive and Mitigation Measures

Recommended Textbooks and Reference books:

1. Douglas J. Futuyma and Mark Kirkpatrick. Evolution. Sinauer. 2017
2. Raghavendra Gadagkar. Survival Strategies: Cooperation and Conflict in Animal Societies. Harvard University Press. 2001
3. Julie L. Lockwood, Martha F. Hoopes and Michael P. Marchetti. Invasion Ecology. Blackwell Publishing. 2007
4. Climate Change 2022: Impacts, Adaptation and Vulnerability. 6th Assessment report. IPCC

BITG192MDC03A: Society and Behavior
Credit: 3 (**Theory**; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit 1: Aggressive behaviors: Basic concept of aggression and its management in various settings- in school: effect of punishments, aggression/ violence by children; effect of social media; road traffic violence; child abuse

Unit II: **Unsocial behaviors**: too much texting, video game playing; Effect of isolation, lack of social contact (studies on isolation cell inmates).

Unit III: Addiction: alcoholism, narcotics.

Unit IV: **Social behavior-related diseases**: STDs, AIDS; Rapid spread of viral diseases in the modern day society: SARS, bioterrorism.

Unit V: Autism: awareness and social response towards mental retardation/ physical impairment

Unit VI: Alzheimer's disease: Caregiving for the aged

Recommended Textbooks and Reference books:

1.Blackout: Remembering the Things I Drank to Forget by Sarah Hepola

2. Social Intelligence: The New Science of Human Relationships by Daniel Goleman.

BITG192MDC03B: Life Through the Lenses

Credit: 3 (**Theory**; Contact hours per week: 3 h; Total credit hour: 48 h)

Unit I: A brief history of the lens (optics)

Discovery of lenses; Light-Refraction, reflection and dispersion; Refraction at spherical surfaces; Refraction by prisms; Power of a lens; Huygen's principle and interference of light

Unit II: Basics of Photography

Photography-a timeline; Early and modern cameras; Digital photography-pixels and megapixels; Camera sensors – full frame, crop sensor, CCD, CMOS; Camera settings-ISO, Aperture, Shutter speed, Depth of field, White balance; Photographic lenses and accessories; photography in natural and artificial light, Processing softwares-lightroom, photoshop; Dissecting the picture; camera care.

Unit II: Macro world

Photographic image in visual communication, photojournalism, Street photography, photographing nature, wildlife photography, macro photography, sports photography.

Unit III: Microworld

Camera as a tool in science; Principles of microscopy- Pocket microscopes, Bright field-Dark field microscopy, Phase contrast microscope, fluorescence microscope, confocal microscope, STED; Microbes in the microscopic world; Forensic microscopy; Electron microscopy-SEM and TEM.

Recommended Textbooks and Reference books:

1. Understanding exposure, Bryan Peterson
2. The digital photography book by Scott Kelby