Course Code		:	1BBTA301C	Cell Biology and Genetics	Semester	:	03
L:T:P		:	3:0:2		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	03 Hrs		Total Marks	:	100
	Total Hrs.	:	90		Credits	:	03

Professional Competency:

Graduates will apply the principles of cell biology and genetics to understand cellular functions, genetic mechanisms, and their applications in disease diagnosis, prevention, and therapeutic interventions while adhering to ethical and professional standards

Course Outcomes:

After completion of the course, student will be able to:

CO1: Explain the structure, organization, and functions of prokaryotic and eukaryotic cells, plasma membranes, cell organelles, cytoskeletal elements, and cell cycle events including senescence, apoptosis, and cancer.

CO2: Analyze mechanisms of cell signaling, membrane transport, protein trafficking, and the role of endomembrane systems in cellular communication and metabolism.

CO3: Apply the principles Mendelian genetics, gene interactions, and molecular genetics concepts to solve inheritance problems, identify genetic material, and evaluate chromosomal disorders

CO4: Apply population genetics, mutation, evolution, and the significance of genetic analysis methods in understanding human health and biodiversity.

UNIT-I — **10 Hrs.**

CYTOLOGY AND CYTOSKELETON

Prokaryotic and eukaryotic cell. Cell Architecture- physio-chemical nature of plasma membrane

Structure & functions of cell organelles: nucleus, mitochondria, chloroplast, ribosomes, peroxisomes, golgi bodies and endoplasmic reticulum.

Cytosketal elements: Cytoskeletal architecture & elements: Microtubules- structure & functions, shaping of the cells and mechanical support. Microfilaments- structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice).

CELL CYCLE

Cell cycle studies: mitosis and meiosis. Cell Birth, lineage and death, Cellular senescence and ageing, Senescence in ageing and age-related disease, Apoptosis and Necrosis. Cancer Cell, Biology. Stem cell types

UNIT-II — **12 Hrs.**

CELL SIGNALLING

Signalling molecules and cell surface, receptors; intracellular signal transduction; G protein coupled receptors; plant growth factors and hormones, Eukaryotic and Prokaryotic cell to cell signalling, endocrine signalling, quorum sensing and intercellular signalling, Signal peptides.

MEMBRANE TRANSPORT

Membrane transport, passive and active transport; transport into prokaryotic cells; Endomembrane System: Golgi, Lysosomes Vesicular Traffic, Secretion, and Endocytosis, exocytosis; entry of viruses and toxins into cells Membrane trafficking: Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria, chloroplast and peroxisomes.

UNIT-III — **10 Hrs.**

GENETICS:

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc., Multiple alleles and groups antigens. Numericals based on

concepts

UNIT-IV | **10 Hrs.**

CHROMOSOMAL DISORDERS

Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinopathies. Disorders of coagulation, Colour blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence.

POPULATION GENETICS: Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis

Text Books:

1. The Cell – A Molecular Approach, Cooper &Hausman, ASM Press, 2004.
2. Molecular Biology of the Cell, B. Alberts, et al., Garland Science, 4th ed. 2002.

Reference Books:

1. Molecular Cell Biology Hardcover, James E. Darnell, Harvey Lodish, David Baltimore,1999

Web links and Video Lectures (e-Resources)

- https://www.youtube.com/watch?v=LFyjJBiltFI
- https://www.biologyonline.com/tutorials/biological-cell-introduction
- https://study.com/academy/topic/cell-biology.html
- https://www.edx.org/learn/cellular-biology
- https://onlinecourses.swayam2.ac.in/cec19_bt12/preview

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)										1 (WK8)	3	3	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)									1 (WK8)	2	3	3
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	1 (WK8)								3	3	3
CO4	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	1 (WK8)							1 (WK8)	2	3	3

Course Code		:	1BBTA302C	Microbiology	Semester	:	03
L:T:P		:	3:0:1		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	3 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	4

Professional Competency:

Evaluate the role of microorganisms in environmental, industrial, and agricultural processes, including water treatment, soil fertility, biofertilizers, fermentation, and production of industrially important microbial products.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Understand the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy

CO2:Analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes

CO3:Analyse the causative organisms of the disease ,their control mechanisms and their effect on society

CO4:Analyse the applied techniques in the environment and create awareness to society.

UNIT-I — **10 Hrs.**

Introduction:

Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase

Contrast microscopy, Fluorescence Microscopy and Electron microscopy(SEM&TEM).

UNIT-II — **12 Hrs.**

METHODS AND TECHNIQUES IN MICROBIOLOGY: Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth pattern (continuous and batch).Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid &alcohol). Staining techniques (Simple and differential).General features of true bacteria (Rickettsia, Mycoplasma and Chlamydia), Prions, Spirochetes

UNIT-III — **10 Hrs.**

MICROBIAL GROWTH AND CONTROL:

Microbial growth Phases, Factors affecting the growth, growth measurement and enumeration. Metabolism; Primary and Secondary metabolites with examples, Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. **MICROBIOLOGY AND DISEASES:**

Common diseases caused by microbes:viruses (Polio,H1N1,SARS,Covid-19,HIV,Hepatitis), bacteria(TB, Cholera, Typhoid, Pneumonia, Plague, Diphtheria, *E.coli* infections), Protozoans (Malaria, Leishmaniasis and Amoebiasis).Common types of fungal infections (ringworm, yeast infection).Microbiome and gut health.

UNIT-IV — **10 Hrs.**

MICROBIOLOGY OF AIR, WATER &SOIL

Aerobiology ,Air sampling techniques and commonly found atmospheric microbe profile. Water sampling techniques, Microbiology of potable water and waste water treatment. Microbiology of soil: Soil fertility, Biofertilizers: VAM, Rhizobium and Azotobacter. **Industrial Microbiology:** Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes

List of Experiments

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) &caring.
2. Media preparation :NA, Peptone broth,PDA ,Macconkey sagar.
3. Isolation of bacteria by serial dilution, pour plate, spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques.(Simple staining differential staining)
7. Observation of motility by hanging drop technique
8. Fermentation of Carbohydrates (gas production)
9. Growth curve of bacteria and yeast.
10. Antibiotic susceptibility testing of bacteria .

Text Books:

1. Pelczar, Chan and Noel Kreig, "Microbiology"- 5th Edition Tata Macgraw Hill ,2010
2. Tortora, Funke and Case, "Microbiology an Introduction" -8th Edition, Pearson Education , 2006.
3. S. Sundara Rajan" College Microbiology"- 2nd edition, Bangalore Vardhana ,2007

Reference Books:

1. Prescott, Harley & Klein, "Microbiology" -7th Edition, WCB/McGraw Hill, Int. Edition. 2008
2. Prescot and Dunn,2002, "Industrial Microbiology"-Agribios India.
3. E Alcamo I. "Fundamentals of Microbiology"6th Ed, Jones & Bartlet, Pub. 2001

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, andWK 4)	2(WK1, WK2, WK3, and WK4)	(WK5)	" "	" "	" "	" "	1	" "	" "	2	3	3	3
CO2	3 WK1, WK2, WK3, andWK 4)	3(WK1, WK2, WK3, and WK4)	2 (WK5)	" "	2 (WK6)	3(WK1, WK5 and WK7)	" "	" "	" "	" "	3 (Wk8)	2	2	3
CO3	3 (WK1, WK2, WK3, andWK 4)	2(WK1, WK2, WK3, and WK4)	2 (WK5)	" "	2 (WK6)	" "	1 (wk9)	" "	" "	" "	2	2	2	3
CO4	3 (WK1, WK2, WK3, andWK 4)	2(WK1, WK2, WK3, and WK4)	2 (WK5)	" "	2 (WK6)	2(WK1, WK5 and WK7)	2 (wk9)	" "	" "	" "	3 (Wk8)	2	2	3

Course Code		:	1BBTA303C	Biochemistry	Semester	:	03
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42+26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs		Total Marks	:	100
	Total Hrs.	:	120		Credits	:	04

Professional Competency:

Analyse biomolecular structures, evaluate metabolic pathways, correlate pathway dysfunctions with clinical disorders, and execute quantitative bio-analytical laboratory techniques.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Interpret the basic concepts of biochemistry and metabolic pathways of the carbohydrates with their disorders and energetic of metabolic reactions.

CO2: Explain lipids metabolism along with regulation and metabolic disorders. Also apply fundamental methods to identify the biomolecules and interpret the specific tests for qualitative analysis.

CO3: Recognize the biosynthetic precursors involved in the amino acid metabolism and its disorders and interpret biochemical data, perform relevant calculations, and draw conclusions from experimental results.

CO4: Comprehend nucleic acid metabolism along with disorders and Present biochemical concepts clearly through written reports, presentations, or discussions using appropriate scientific language

UNIT-I — **12 Hrs.**

INTRODUCTION TO BIOCHEMISTRY

Biomolecules – function and properties, pH, Henderson Hesselbalch equation, buffers and their properties, concentration of solutions.

METABOLISM OF CARBOHYDRATE

Introduction to metabolism. Principle biomolecules involved in the energy flow in the metabolic cycle. Glycolysis, TCA cycle, Glyoxylate cycle, NADPH Cycle, Calvin Cycle. Gluconeogenesis and regulation of gluconeogenesis, pentose phosphate pathway, Electron transport chain, oxidative phosphorylation, bioenergetics of reactions. Disorders of carbohydrate metabolism (lactose intolerance, galactosemia, diabetes).

UNIT-II — **10 Hrs.**

METABOLISM OF LIPID

Biosynthesis of fatty acids (palmitic acid cholesterol, phospholipids and glycolipids). Regulation of fatty acid biosynthesis. Biodegradation of fatty acid. Ketone bodies production during starving and diabetes. Disorders of lipid metabolism (atherosclerosis, acidosis-kesosis, Gaucher disease and LDL-hypercholesterolemia).

UNIT-III — **10 Hrs.**

METABOLISM OF AMINO ACIDS:

Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family) - Aspartate, Asparagine, Methionine, Lysine, Threonine. Biodegradation of amino acids- deamination, transamination and urea cycle. Regulation of amino acid metabolism.

Disorders of amino acid metabolism (Phenylketonuria, Albinism, Maple Syrup Urine Disease, Tyrosinemia).

UNIT-IV — **10 Hrs.**

METABOLISM OF NUCLEIC ACIDS

Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP. De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines & pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Disorders of nucleic acid metabolism. (Gout, Lesch-Nyhan syndrome, hyper and

hypo uricemia, adenosine deaminase deficiency, SIDS).

List of Experiments:

1. pH measurements, volume / weight measurements, concentration units, sensitivity Specificity, precision, accuracy, preparation of reagents and buffers of constant strength.
2. Qualitative tests for carbohydrate and lipids.
3. Qualitative tests for amino acids and proteins.
4. Estimation of Glucose by Folin Wu method/ O-Toluidine method
5. Estimation of amino acid by ninhydrin method.
6. Estimation of DNA by DPA method
7. Determination of Saponification value and iodine value of lipids.
8. Estimation of proteins by Lowry's method.
9. Estimation of urea by DAMO method.
10. Estimation of iron by Wong's method.

Text Books:

1. David L. Nelson and Michael Cox., "Lehninger Principles of Biochemistry" 7th edition, W.H Freeman Co., Pub.2017
2. U. Sathyanarayana, "Biochemistry" -5th edition, Books and Allied Pub., 2022
3. Beedu Sashidhar Rao and Vijay Deshpande, "Experimental Biochemistry" -I.K.Intl., 2013

Reference Books:

1. Lubert Stryer, "Biochemistry" -8th edition Freeman & Co., Pub.,2021
2. Voet & Voet, "Biochemistry"- 4th edition, John Wiley,New York Pub.2011
3. Thomas M. Davlins," Biochemistry with clinical correlations" 7th edition Wiley-Liss., 2010
4. Rodney Boyer, "Modern Experimental Biochemistry"-Pearson Education Pub, 2000.
5. Pattabhiraman,"Practical Biochemistry" 4th edition All India publisher and distributor., 2015
6. Plummer D. T.,"Practical Biochemistry" -TMH Pub. 1988

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3
CO3	2 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	-	3 (WK2 and WK6)	-	3 (WK9)	-	-	-	3 (WK8)	3	3	3

Course Code		:	1BBTA304C	Immunotechnology	Semester	:	03
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42 + 26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	04

Professional Competency:

Analyze immune system functions, diagnose immunological disorders, develop vaccines, and perform advanced lab techniques for clinical and research purposes.

Course Outcomes:

After completion of the course student will be able to:

1. Interpret the properties and functions of immune system for research and medicinal field.
2. Identify the functions of humoral and cell mediated immune system for disease diagnosis and analyzing the drug.
3. Asses the immunological disorders and develop the vaccines.
4. Apply the major immunological laboratory techniques and their application to both clinical analysis and experimental research.

UNIT-I — **12 Hrs.**

IMMUNE SYSTEM:

Introduction, Cells and Organs of the immune system: Lymphoid cells and myeloid cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT). Innate and adaptive immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants. Antibodies: their structure and function, Immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and subclasses (isotypic, allotypes, idiotypes and anti-idiotypic antibodies). Cytokines and their role in immune response.

UNIT-II — **10 Hrs.**

HUMORAL AND CELL MEDIATED IMMUNITY:

Introduction to humoral and cell mediated immunity. B-lymphocytes maturation and mechanism of activation. Antibody genes and generation of diversity, Class Switching mechanism. T-cell maturation and mechanism of activation. Major Histocompatibility Complex: MHC I and MHC II structure and functions. Antigen processing and presentation process.

Complement system and its pathways (classical, alternative and lectin pathway).

UNIT-III — **10 Hrs.**

IMMUNOLOGICAL DISORDERS:

Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune disorders. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: Types of transplantations, Immunological basis of graft rejection.

Vaccines: Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines, inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.

UNIT-IV — **10 Hrs.**

IMMUNODIAGNOSIS:

Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, Immuno-electrophoresis, Immunofluorescence, fluorescence activated cell sorting (FACS) analysis. Production of monoclonal and polyclonal antibodies and their applications.

List of Experiments:

1. Agglutination Technique: Blood group identification and Rh factor
2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL
3. Ouchterlony Double Diffusion (ODD)
4. Radial Immunodiffusion (RID)
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Rocket immunoelectrophoresis (RIEP)
7. Western blot (IGg Purification)
8. ELISA**/** DOT Blot.

Text Books:

1. Roitts, "Essential Immunology" 13th edition, Wiley Blackwell, 2017
2. Kuby, J., "Immunology", 8th edition, W H Freeman Publishers, 2019
3. Rastogi, S. C., "Immunodiagnostics", 1st Edition, New Age International, 2005

Reference Books:

1. Chakravarthy, A.K. "Immunology & Immunotechnology", Oxford University Press, 2006

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3 (WK1 to WK4)	2 (WK1 to WK4)	2 (WK5)	1 (WK 8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO2	3 (WK1 to WK4)	2 (WK1 to WK4)	2 (WK5)	2 (WK 8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO3	3 (WK1 to WK4)	3 (WK1 to WK4)	3 (WK5)	2 (WK 8)	3 (WK2 and WK6)	-	-	1	-	-	3 (WK8)	3	3	2
CO4	3 (WK1 to WK4)	2 (WK1 to WK4)	2 (WK5)	2 (WK 8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	1	-	-	3 (WK8)	3	3	2

Course Code		:	1BBTA308C	**Unit Operations and Transport Processes**	Semester	:	03
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Ability to apply the fundamental principles of heat, and mass transfer to analyze, design, and optimize individual chemical engineering unit operations and fluid flow systems, ensuring efficient, safe, and sustainable industrial process operations.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Analyze fluid behavior, flow profiles, and transport dynamics in biological and industrial fluid systems using fundamental equations of fluid flow and flow measurement techniques.

CO2: Solve steady-state heat conduction problems and design heat exchange equipment by applying Fourier's Law, convective transport correlations, and the Log Mean Temperature Difference (LMTD) method.

CO3: Competent in solid-fluid mechanical separation and thermal processing operations to operate bioprocesses

CO4 Analyze molecular diffusion, design diffusional separation operations and evaluate bioreactor mixing behaviors.

UNIT-I	**10 Hrs.**

Fluid Flow Operations & Biofluid Mechanics

Fluid Properties and Rheology: Characteristics of fluids, density, and viscosity. Newton's law of viscosity. Distinction between Newtonian and non-Newtonian fluids. Rheological behavior and biological implications (biofluid mechanics).

Fluid Statics: Pascal's law, barometric equation, and hydrostatic pressure. Manometers: types, working principles, and pressure measurement calculations.

Fluid Dynamics: Laminar and turbulent flow regimes. Reynolds number (Re) and its practical importance. Velocity distribution profiles in laminar and turbulent flows.

Mixing fundamentals: aeration and agitation mechanics.

Basic Equations of Fluid Flow: Continuity equation (conservation of mass). Euler's equation of motion. Derivation of Bernoulli's theorem, its application, and engineering corrections (friction and pump work additions).Flow Measurement: Principles, working, and equations for variable head meters (Orifice meters, Venturi meters) and variable area meters (Rotameters).

UNIT-II	**10 Hrs.**

Conduction: Modes of heat transfer. Fourier's law of conduction and thermal conductivity (k). Steady-state heat conduction through single-layer slabs, multilayer composite walls, and cylindrical geometries. Conceptual numerical problems on conductive resistance.

Convection: Mechanism of forced and natural convection. Concept of individual and overall heat transfer coefficients (h and U). Combined heat transfer mechanisms (conduction-convection-conduction series). Fundamentals of boiling and condensation heat transfer phases.

Heat Transfer Equipment: Construction and working principles of Double Pipe and Shell and Tube heat exchangers. Flow configurations: co-current vs. counter-current flow. Thermal Design Concepts: Derivation and application of Log Mean Temperature Difference (LMTD). Elementary sizing and design calculations for heat exchangers using LMTD and heat balance equations.

UNIT-III	**10 Hrs.**

Mechanical and Separation Operations

Filtration: Mechanisms and types of filtration. Distribution of overall pressure drop across the cake and filter medium (resistance modeling). Filter media characteristics and the role of filter aids. Factors affecting the rate of filtration. Equipment: Operational principles of Plate and Frame Filter Presses and Rotary Drum Filters.

Theory of Settling & Sedimentation: Mechanics of particulate settling (Free vs. Hindered settling). Stoke's law, Newton's law, and terminal settling velocity. Concept of batch sedimentation and evaluation of the Settling Velocity Curve. Equipment: Industrial thickeners and cyclone separators.

Flotation: Principles of surface chemistry-driven separation and froth flotation mechanics.

Evaporation & Crystallization: Governing principles, heat balances, and equipment configurations.

Drying: Internal and external mass transfer mechanisms, drying rate curves (constant and falling rate periods), and calculation of total drying time.

UNIT-IV | **10 Hrs.**

Mass Transfer Fundamentals & Bioreactor Transport

Diffusion & Mass Transfer Coefficients: Fick's law of molecular diffusion. Steady-state molecular diffusion in stagnant fluids and laminar flow regimes. Measurement techniques for diffusivity. Mass transfer coefficients and empirical correlations.

Diffusional Separation Processes: Phase equilibrium principles and mass transfer phenomena in Liquid-Liquid Extraction, Gas Absorption, Adsorption, and Desorption operations.

Distillation: Vapor-liquid equilibrium (VLE) relationship. Operational methods: Simple batch distillation, Flash (equilibrium) distillation, and Continuous Fractional distillation.

Stage-Wise Calculations: Graphical estimation of ideal stages/trays in a distillation column using the McCabe-Thiele method (operating lines, feed line q-equations, and total/minimum reflux limits).

Agitation and Mixing: Dynamics of homogeneous and heterogeneous mixtures. Flow patterns generated by different impeller geometries (axial vs. radial flow). Mechanics of dispersing gases into liquids.

Reference Books:

1. McCabe, W. L., Smith, J. C., & Harriott, P. Unit Operations of Chemical Engineering. McGraw-Hill.
2. Geankoplis, C. J. Transport Processes and Separation Process Principles. Prentice Hall.
3. Treybal, R. E. Mass-Transfer Operations. McGraw-Hill.
4. Doran, P. M. Bioprocess Engineering Principles. Academic Press.

Web links and Video Lectures (e-Resources)

1. **NPTEL: Mechanical Unit Operations: Instructor:** Prof. Nanda Kishore (IIT Guwahati)
2. **NPTEL:** Transport Processes I: Heat and Mass Transfer Instructor: Chemical Engineering Faculty (NPTEL / Swayam Ecosystem)
3. **NPTEL:** Mass Transfer Operations I & II Instructor: Prof. Bishnupada Mandal (IIT Guwahati)
4. edX - Bioprocess Engineering Principles (Top Technical Universities)

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK 5)	1 (WK8)	-	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	3	2	-
CO2	3 (WK1, WK2, WK3,	3 (WK1, WK2, WK3,	3 (WK 5)	2 (WK8)	1 (WK2 ,WK6)	1	-	-	-	1	1 (WK8)	1	3	1

	and WK4)	and WK4)												
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK 5)	2 (W K8)	-	2 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK 5)	2 (W K8)	2 (WK2 ,WK6)	1 (WK1, WK5, WK7)	-	-	-	1	1 (WK8)	2	3	1

	Course Code	:	1BBTA306C	Cell Culture Techniques	Semester	:	03
	L:T:P	:	2:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	28 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	26 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	60 Hrs		Credits	:	02

Professional Competency:

Apply plant and animal cell culture principles and laboratory techniques to establish, maintain, characterize, preserve, and utilize cell cultures for research, biopharmaceutical production, tissue engineering, regenerative medicine, and agricultural biotechnology while adhering to biosafety, bioethics, and quality assurance practices.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Apply the fundamental principles of plant cell culture in Plant Tissue culture laboratories

CO2: Apply various plant tissue culture techniques for crop improvement.

CO3: Demonstrate animal cell culture techniques including cell line establishment, sub culturing, and media formulation in cell culture.

CO4: Evaluate cell viability, cytotoxicity, and contamination in cultured cells using appropriate assays in animal cell culture research.

UNIT-I **8 Hrs.**

PLANT CELL CULTURE:

History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture. Cellular totipotency, cytodifferentition, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberlins, cytokinins. Stoichometry of cell growth and product formation.

UNIT-II **6 Hrs.**

CULTURE TECHNIQUES AND APPLICATIONS:

Protoplast culture, somatic hybridization, haploid production, micro propagation, somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.

UNIT-III **8 Hrs.**

ANIMAL CELL CULTURE TECHNIQUES

History and development of mammalian cell culture. Lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.

UNIT-IV **8 Hrs.**

CELL LINE CHARACTERIZATION AND MAINTENANCE

Measurement of Cell viability-Dye exclusion and inclusion tests and Cytotoxicity assay –MTT, clonogenic assay. Preservation of cell lines. Characterization of cell lines. Cell line contaminations, detection and control. Stem cells & their applications.

Text Books:

1. R.Ian Freshney, Culture of Animal cells A Manual of Basic Technique and Specialized Applications-8th Edition-.Wiley Less, 2021
2. H. S. Chawla, Introduction to Plant biotechnology by, 2nd Edition, Oxford and IBH Publishers, 2010
3. B. D. Singh, Biotech Expanding Horizons, Kalyani Publishers, 2010.

Reference Books:

1. Ranga, M. M. Animal Biotechnology (3rd Edition), (2021).
2. Bhojwani, S. S., & Dantu, P. K. Plant Tissue Culture: An Introductory Text. Springer, (2013).

Web links and Video Lectures (e-Resources)

1. https://www.getyoureducation.net/course/cell-culture-technologies-1?utm_source
2. https://www.getyoureducation.net/course/cell-culture-technologies-1?utm_source
3. IGNOU eGyanKosh – Animal Cell Culture Unit

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3 (WK,WK2 WK3, WK4)	2 (WK, WK2 WK3, WK4)	1 (WK5)	1 (WK8)	1 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (WK8)	3	3	2
CO2	3 (WK,WK2 WK3, WK4)	3 (WK, WK2 WK3, WK4)	2 (WK5)	2 (WK8)	2 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (WK8)	3	3	2
CO3	3 (WK,WK2 WK3, WK4)	2 (WK, WK2 WK3, WK4)	2 (WK5)	2 (WK8)	2 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (WK8)	3	3	2
CO4	3 (WK,WK2 WK3, WK4)	3 (WK, WK2 WK3, WK4)	2 (WK5)	3 (WK8)	2 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	2 (WK8)	3	3	2

	Course Code	:	1BBTA307L	**Unit Operations and Transport Processes Lab**	Semester	:	06
	L:T:P	:	3:0:0		Course Type	:	PCCL
Hours/Sem.	Teaching	:	26 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	00 Hrs.		SEE Marks	:	50
	Exam	:	6 Hrs.		Total Marks	:	100
	Total Hrs.	:	32 Hrs.		Credits	:	01

Professional Competency:

Ability to apply the fundamental principles of heat, and mass transfer to analyze, design, and optimize individual chemical engineering unit operations and fluid flow systems, ensuring efficient, safe, and sustainable industrial process operations.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Experimentally evaluate head losses, and calibrate differential pressure and variable-area flow meters.
CO2: Estimate thermal conductivity in composite matrices and analyze convective transport parameters and thermal effectiveness in multi-flow heat exchangers. CO3: Construct and evaluate transport rate profiles for solid-fluid operations by analyzing particulate settling behaviors and biological product drying curves.
CO4: Evaluate phase-equilibria transport performance by executing binary fractional distillation and solid-liquid extraction operations.

List of Experiments — **26 per Batch**

1. Verification of Bernoulli's Theorem & Head Loss Evaluation
2. Calibration of Flow Measurement Devices Objective
3. Thermal Conductivity of Composite Wall Structures
4. Evaluation of Convective Heat Transfer Coefficients
5. Performance Evaluation of a Double-Pipe Heat Exchanger
6. Batch Sedimentation
7. Settling Velocity Profile Analysis
8. Drying Kinetics of Biological Products
9. Extraction (S/L)
10. Distillation of binary mixture

Open Ended Experiment(s) OR Open Ended Program(s)

1. Rheological Characterization of Biological Fluids
2. Visual Determination of Flow Regimes (Reynolds Experiment)
3. Filtration Kinetics Using a Plate and Frame Filter Press

Reference Books:

1. McCabe, W. L., Smith, J. C., & Harriott, P. Unit Operations of Chemical Engineering. McGraw-Hill.
2. Geankoplis, C. J. Transport Processes and Separation Process Principles. Prentice Hall.
3. Doran, P. M. Bioprocess Engineering Principles. Academic Press.

Web links and Video Lectures (e-Resources)

1. **NPTEL: Mechanical Unit Operations: Instructor:** Prof. Nanda Kishore (IIT Guwahati)
2. **NPTEL:** Transport Processes I: Heat and Mass Transfer Instructor: Chemical Engineering Faculty (NPTEL / Swayam Ecosystem)
3. **NPTEL:** Mass Transfer Operations I & II Instructor: Prof. Bishnupada Mandal (IIT Guwahati)
4. edX - Bioprocess Engineering Principles (Top Technical Universities)

Course Outcomes:														
Course Outcomes	**Programme Outcomes**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	1 (WK8)	-	1 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	3	2	-
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	1 (WK2,WK6)	1	-	-	-	1	1 (WK8)	1	3	1
CO3	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	-	2 (WK1, WK5, WK7)	-	-	-	-	1 (WK8)	2	3	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	2 (WK2,WK6)	1 (WK1, WK5, WK7)	-	-	-	1	1 (WK8)	2	3	1

	Code	:	1BBTA401C	**Biostatistics and Tools**	Semester	:	04
	LTP	:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	44 Hrs		SEE Marks	:	50
	Exam	:	06 Hrs		Total Marks	:	100
	Total Hrs.	:	120 Hrs		Credits	:	04

Professional Competency:

Apply statistical methods and computational software to analyze biological data in the field of the research and industry

Course Outcomes:

After completion of the course student will be able to:

CO1: Analyze the data using various statistical tools in the field of research and industry.
CO2: Investigate the probability distributions of the data.
CO3: Apply the knowledge of inferential statistics to analyze the data using statistical tools.
CO4: Design and analyze the experimentation using statistical software tools for the field of research and industry

UNIT-I — **12 Hrs.**

INTRODUCTION AND DESCRIPTIVE STATISTICS

Scope of biostatistics, common terms in statistics. Types of numerical data, Sampling techniques- random (simple, stratified and systematic) non random sampling - (Judgement and convenience). Presentation of data: Diagrammatic and graphical represent, Measure of central tendency (meaning of central tendency, arithmetic mean, median, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, mean deviation and standard deviation, coefficient of variation.

UNIT-II — **10 Hrs.**

BIVARIATE ANALYSIS AND PROBABILITY DISTRIBUTIONS

Correlation- types, reasons and methods of estimating correlation, Karl Pearson's coefficient of correlation. Linear Regression analysis. Probability theories: Addition and Multiplication theorem of probability. Probability distributions: Discrete probability distributions: Binomial and Poisson distribution. Continuous probability distribution – normal, properties of normal curve.

UNIT-III — **10 Hrs.**

INFERENTIAL STATISTICS

Statistical Estimation: Point estimation and interval estimation, Testing of hypothesis (T, Z and Chi square - test), Types of Errors: Type-I and Type-II, Analysis of variance ANOVA: one way and two way classifications.

UNIT-IV — **10 Hrs.**

DESIGN AND ANALYSIS OF EXPERIMENTS:

Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burman design, Response surface methodology (RSM).

LIST OF EXPERIMENTS

1. Create Data file and plot Diagram and Graphs in SPSS software.
2. Calculate and interpret Mean, Median, Mode, Standard Deviation and Variance for data.
3. Calculation & interpretation of correlation and regression between variables.
4. Perform t- test for determining a significance difference between two groups.
5. Calculation and interpretation of Chi-square test.
6. ANOVA- one-way analysis & two-way analysis.
7. Experimental Research Design – CRD- Analysis.
8. Experimental Research design – RCBD- Analysis.
9. Experimental Research design – Latin square Design- Analysis.

10. Design and analysis of screening experiments using Plackett–Burman designs.
11. Design and analysis of experiments based on response surface methodology (RSM).

Text Books:

1. Khan and Khanum, "Fundamentals of Biostatistics" (6rd edition), Ukaaz Publication, 2016
2. Agarwal B.L. ,"Basic statistics" (6th edition), New age international Publishers,2018

Reference Books:

1. Rastogi V. B., "Biostatistics", 3rd Edition, Medtech Publication, 2015
2. Bradley Jones, Douglas C. Montgomery "Design of Experiments: A Modern Approach" 1st Edition, Wiley Publication, 2019

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3 (WK1 to WK4)	3 (WK1 to WK4)	2 (WK5)	3 (WK8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO2	3 (WK1 to WK4)	3 (WK1 to WK4)	2 (WK5)	3 (WK8)	3 (WK2 and WK6)	-	-	-	-	-	3 (WK8)	3	3	-
CO3	3 (WK1 to WK4)	3 (WK1 to WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7).	-	-	-	-	3 (WK8)	3	3	-
CO4	3 (WK1 to WK4)	3 (WK1 to WK4)	3 (WK5)	3 (WK8).	3 (WK2 and WK6)	2 (WK1, WK5, and WK7)	-	-	-	-	3 (WK8)	3	3	2

	Code	: 1BBTA403C	**BIOPROCESS PRINCIPLES AND CALCULATIONS**	Semester	:	06
	LTP	: 3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	: 42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	: 42 Hrs.		SEE Marks	:	50
	Exam	: 6 Hrs.		Total Marks	:	100
	Total Hrs.	: 90 Hrs.		Credits	:	03

Professional Competency:

Ability to apply engineering and mathematical fundamentals to formulate and systematically solve steady-state and unsteady-state mass and energy balances for physical unit operations, chemically reacting systems, and biological growth environments

Course Outcomes:

After completion of the course, student will be able to:

CO1: Fundamentals & Gas Laws: Perform precise unit conversions, establish dimensional consistency, and apply gas laws to determine the volumetric, molar, and density characteristics of multi-component mixtures. (Bloom's Level: Apply)

CO2: Material Balances (Non-Reacting Systems): Develop process block diagrams and formulate steady-state/unsteady-state material balance equations to solve quantitative operational problems in non-reacting systems like distillation, evaporation, and drying. (Bloom's Level: Analyze)

CO3: Stoichiometry & Reacting Systems: Solve complex material balances for reacting chemical networks by identifying limiting/excess reactants and evaluating industrial process efficiency using conversion, yield, and selectivity metrics. (Bloom's Level: Analyze)

CO4: Energy Balances & Bioprocess Stoichiometry: Apply standard thermal concepts (heats of reaction, formation, combustion) to perform industrial energy balances, and construct macro-chemical elemental balances to determine the yield coefficients and degrees of reduction for microbial growth systems. (Bloom's Level: Evaluate / Synthesize)

UNIT-I — 10 Hrs.

Introduction to Engineering Calculations

Dimensions and System of Units:

Introduction, Fundamental and Derived Units, Fundamental and Derived Quantities; System of Units (FPS, CGS, MKS, SI); Conversion of Units, Inter-conversion; Conceptual Numericals

Basic Chemical Engineering Calculations:

Atomic, Molecular and Equivalent weights; molar concept; Gram atom; Gram mole; Equivalent Weight; Concept of Normality, Molarity and Molality. Method of Expressing the Composition of Mixtures and Solutions, weight fraction, mole fraction, Percentage by weight, mole percent and volume percent; Concept of PPM (Parts Per Million); Conceptual Numericals; Gases, Ideal Gas Law, Dalton's Law, Partial Pressure, Amagat's Law, Gaseous Mixtures, Relationship between Partial Pressure and Mole Fraction of Component Gas; Average Molecular Weight of Gas Mixture; Density of Gas Mixture; Conceptual Numericals

UNIT-II — 10 Hrs.

Material Balance without Chemical Reactions

General material balance equation for steady and unsteady states; Generalized Block Diagram of operations showing input and output; Material balance equations for Unit Operations like Distillation, Evaporation, Crystallization, Mixing, Drying, Extraction; Material balances and conceptual Numericals on Distillation, Evaporation, Crystallization, Mixing, and Drying Unit Operations.

UNIT-III — 12 Hrs.

Material Balance Involving Chemical Reactions

Generalized material balance equations, stoichiometry, Principles of stoichiometry, stoichiometric ratio, proportion, coefficient, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity, Material Balance, and Conceptual Numericals on different Unit processes

UNIT-IV	10 Hrs.

Energy Balance:

General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases, and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion, and calorific value.

Stoichiometry of Microbial growth and Product formation

Stoichiometry of cell Growth and Product Formation- elemental balances, degrees of reduction of substrate and biomass; available-electron balances; yield coefficients of biomass and product formation

Reference Books:

1. Basic Principles and Calculations in Chemical Engineering: Authors: David M. Himmelblau and James B. Riggs (Prentice Hall).
2. Bioprocess Engineering: Basic Concepts: Authors: Michael L. Shuler, Fikret Kargi, and Matthew DeLisa (Prentice Hall).
3. Chemical Process Calculations: D.C. Sikdar's (PHI Learning)

Web links and Video Lectures (e-Resources)

1. **NPTEL:** Core Video Lecture Series (NPTEL / SWAYAM): Mass Balance Book keeping: Mass Transfer Operations I (IIT Bombay)
2. **NPTEL:** Bioprocess Engineering (IIT Roorkee)
3. **Digital Portals & Solved Problem Repositories LearnChemE** - Process Calculation Tutorials (University of Colorado Boulder)
4. Chemical Engineering Virtual Labs (NMEICT / MHRD)

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO 1	3 (WK1, WK2, WK3, and WK4)	2 (WK1, WK2, WK3, and WK4)	-	-	1 (WK2, WK6)	-	-	-	-	-	1 (WK8)	1	1	-
CO 2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	1 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	1	1 (WK8)	1	3	-
CO 3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	2 (WK5)	2 (WK8)	1 (WK2, WK6)	1 (WK1, WK5, WK7)	-	-	-	1	1 (WK8)	2	3	-
CO 4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	3 (WK8)	2 (WK2, WK6)	2 (WK1, WK5, WK7)	-	-	-	2	2 (WK8)	3	3	2

	Code	:	1BBTA404C	Molecular Biology	Semester	: 04
	LTP	:	3:0:2		Course Type	: IPCC
Hours/Sem.	Teaching	:	42 Hrs+26 Hrs		CIE Marks	: 50
	Learning (TW+SL)	:	44 Hrs		SEE Marks	: 50
	Exam	:	08Hrs		Total Marks	: 100
	Total Hrs.	:	120 Hrs		Credits	: 04

Professional Competency:

Apply molecular biology principles and experimental techniques to study gene structure, gene regulation, genetic engineering, and molecular diagnostics in biotechnology and pharmaceutical sciences.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Analyze the basic aspects of replication and apply the knowledge of practical aspects in various molecular biology based applications.

CO2: Acquire working knowledge on the mechanism of transcription, translation and post translational processes along with their applications in research.

CO3: Apply research-based knowledge of gene regulation mechanism in prokaryotes and eukaryotes in the field of Biotechnology.

CO4: Select and apply the steps of transposition, Proto-oncogenes conversion and molecular mechanism of genetic recombination in treating diseases.

UNIT-I **10 Hrs.**

Introduction

Genes and their location. Information flow in biological systems: Central Dogma, Cell Signaling (signal transduction)-molecular mechanism, types of intercellular signaling. Genetic code-its features, codon and anticodon. Wobble hypothesis, Reverse genetics.

Replication

Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. Mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage and Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).

UNIT-II **11 Hrs.**

Transcription

Mechanism of transcription in prokaryotes and eukaryotes, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing-Splicing, Capping and Polyadenylation, Si RNA, Antisense RNA technology.

Translation

Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation in Prokaryotes and Eukaryotes, Structure and function of prokaryotic and eukaryotic ribosomes, Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation. Post translational modification.

UNIT-III **11 Hrs.**

Gene Expression In Prokaryotes

Regulation of gene expression in prokaryotes: operon model-structure and function, galactose and lactose operon, tryptophan operon-regulation by Repression and Attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression.

Gene Expression In Eukaryotes

Regulation of eukaryotic gene expression, Gene regulation- transcriptional control-by chromatin modification and methylation, RNA processing control- micro RNAs, Translational control, and post-translational level control. Hormonal regulation- peptide and steroid hormones, super secondary structures-Helix turns Helix. Zinc fingers and Leucine

UNIT-IV	Hrs.		

Transposons And Oncogenes

Transposons- replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (Mc Clintock's work), Cut and paste transposition, -Oncogenes and Protooncogenes, Tumour suppressor genes, retroviruses and its life cycle.

Genetic Recombination

Genetic recombination in bacteria- transformation, transduction and Conjugation, Molecular mechanism of recombination- homologous recombination (Holliday model), site specific recombination.

List of Experiments:

1. Study of standard practices in Molecular Biology lab
2. Preparation of common molecular biology lab buffers (TAE Buffer and TE Buffer)
3. Agarose gel electrophoresis.
4. Standard Operating Procedure for Centrifuge and Gel documentation unit.
5. Study of absorption spectra of nucleic acids.
6. Isolation of genomic DNA (plant / animal / microbial sources).
7. Isolation of plasmid DNA from E. coli.
8. Quantification of DNA using UV–Visible spectrophotometer
9. Estimation of RNA by orcinol method.
10. Purity of nucleic acids by UV-Vis Spectrophotometer.
11. UV -Vis survival curve of E.coli
12. PAGE (DEMO).

Text Books:

1. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick, Molecular Biology of the Gene ,5th Edition, Pearson edition
2. David Nelson and Michael Cox, Lehninger, Principles of Biochemistry (6th Edition), W.H. Freeman, 2017.

B.R. Glick, J.J. Pasternak and C.L Patten, "Molecular Biotechnology – Principles and applications of recombinant DNA", ASM Press, 6th edition, 2022

Reference Books:

3. Lewin's genes XII Burlington, Massachusetts: Krebs, Jocelyn E., Goldstein, Elliott S., Kilpatrick, Stephen T., Jones & Bartlett Learning, 2018.
4. Gene Cloning and DNA Analysis – An Introduction, T.A. Brown, Wiley-Blackwell Science, 7th edition, 2018.
5. Sambrook & Russell, Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab, 2002

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
CO1	2 (WK1 WK2 WK3 WK4)	2 (WK1 WK2 WK3 WK4)	2 (WK5)	2 (WK8)	1 (WK2 and WK6)	2 (WK1, WK5, and WK7).	-	-	-	-	3 (WK8)	2	2	2
CO2	2 (WK WK2 WK3 WK4)	2 (WK1 WK2 WK3 WK4)	2 (WK5)	2 (WK8)	3 (WK2 and WK6)	2 (WK1 WK5 and WK7).	-	-	-	-	3 (WK8)	2	3	2
CO3	2 (WK WK2 WK3 WK4)	2 (WK1 WK2, WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK2 and WK6)	2 (WK1, WK5, and WK7).	-	-	-	-	3 (WK8)	2	3	2
CO4	2 (WK,WK 2,WK3, WK4)	2 (WK1 ,WK2, WK3, WK4)	3 (WK5)	3 (WK8)	3 (WK2 and WK6)	2	-	-	-	-	3 (WK8)	2	3	2

	Course Code	:	1BBTA405C	UPSTREAM PROCESSING TECHNOLOGY	Semester	:	04
	L:T:P	:	3:0:0		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42 Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs		SEE Marks	:	50
	Exam	:	03 Hrs		Total Marks	:	100
	Total Hrs.	:	120		Credits	:	04

Professional Competency:

Develop the knowledge and skills to design, operate, monitor, and optimize upstream bioprocesses, including media preparation, sterilization, inoculum development, bioreactor operation, and process control for efficient and safe production of bioproducts.

Course Outcomes:

After completion of the course, student will be able to:

1. Identify the component parts of fermentor and fermentation system.
2. Select the raw material, prepare and sterilize the media and also to optimize the industrial media using Design of experiments.
3. Develop/design the industrially important microbes for industrial scale processes.
4. Operate the reactors for Plant, Animal and GMOs.

UNIT-I — **12 Hrs.**

FERMENTATION PROCESS

Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications, Types of Fermentors.

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT-II — **10 Hrs.**

RAW MATERIALS AND MEDIA

Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization. Different methods for optimization (Plackett-Burman Design, RSM)

UNIT-III — **10 Hrs.**

MICROBIAL SYSTEM

Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculum from laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Trouble shooting during fermentation process (microbial contamination).

SECONDARY METABOLITE PRODUCTION: secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.

UNIT-IV — **10 Hrs.**

PLANT CELL SYSTEM

Isolation and culture of single cells, Bioprocess using plant cell cultures. Bioreactors for suspension cultures, immobilized cells and organized tissues. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics).

ANIMAL CELL SYSTEM

Scale up in suspension (stirred and static), monolayer (roller bottles, nunc cell factory microcarriers culture) and Perfusion culture (fixed and fluidized bed reactors).Factors affecting cell culture,Growth monitoring.Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints- genetic instability, mass

transfer and others.Large scale production of insulin by mammalian cell culture. Cellbank preparation & cell reviving techniques.

MONOCLONAL ANTIBODY PRODUCTION: SUDBRCS (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture).

LIST OF EXPERIMENTS

1. Microbial Growth kinetics and Estimation of Monod parameters in Batch Bioreactor/Batch culture.
2. Production and estimation of citric acid from *Aspergillus niger.*
3. Preparation and production of ethanol in fermenter: Study of growth, product formation, and substrate utilization.
4. Bioprocess Modeling using SuperPro Designer: Flow sheeting of the Bioprocess using SuperPro Designer, Design of various Bioreactors using SuperPro Designer.
5. Solid-liquid separation method: Removal of Intracellular Proteins by cell disruption methods.
6. Solid-liquid separation method: Separation of biomass and extracellular components by Filtration (Cross flow) and Centrifugation.
7. Product enrichment operations: Precipitation of a bioproducts from crude solution or the extract.
8. Product enrichment operations: Liquid-liquid and Aqueous two – phase extraction of bio products from biological sources.
9. Extraction and estimation of bioactive compounds from natural sources.
10. Lyophilization of any bioproducts
11. Analysis of biomolecules/bioactive compounds by HPLC

Text Books:

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Aditya books (P) Ltd. New Delhi 1997.
2. Bioprocess Engineering by Michael L. Shuler, 2nd Edition Shuler & Kargi, Fikret Kargi, Academic Internet Publishers, 2006.
3. Culture of animal cells by Ian Freshney 4th Edition. John Willey & Sons Publ,2008
4. Animal Biotechnology by Murray Moo-Young Pergamon Press, , 2008

Reference Books:

1. Introduction to plant Biotechnology by H.S. Chawla, Second edition, Oxford & IBH Publisher
2. Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996). Elsevier

Course Outcomes:

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3(WK1 WK2, WK3 ,WK4)	1(WK1 WK2, WK3 ,WK4)	-	-	-	-	-	-	-	-	-	1	3	-
CO2	-	3(WK1 WK2, WK3 ,WK4)	-	-		-	-	-	-	-	-	-	3	3
CO3	2(WK1 WK2, WK3 ,WK4)	2(WK1 WK2, WK3 ,WK4)	3**(WK5)**	1(WK8)	1**(WK 2 and WK6)**	-	-	-	-	2	1	3**(WK8)**	3	-
CO4	2(WK1 WK2, WK3 ,WK4)	-	-	-	-	-	-	-	-	3	1	-	3	-

	Code : 1BBTA406C		Environmental Biotechnology	Semester : 04	
	LTP : 3:0:0			Course Type : PCC	
Hours/Sem.	Teaching : 42 Hrs			CIE Marks : 50	
	Learning (TW+SL) : 42 Hrs			SEE Marks : 50	
	Exam : 06 Hrs			Total Marks : 100	
	Total Hrs. : 90 Hrs			Credits : 03	

Professional Competency:

Design and apply biological systems using microorganisms and plants to treat waste, clean up environmental pollutants, recover metals, and conserve biodiversity.

Course Outcomes:

After completion of the course student will be able to

CO1: Interpret the scope of Envionmental Biotechnology and concepts of Bioaccumulation.

CO2: Develop different treatment methods for waste water and solid waste by using BT approach.

CO3: Apply bioleaching process for metal recovery and bioremediation processes to remove environmental contaminants.

CO4: Identify and apply BT approach for biodiversity conservation.

UNIT-I **10 Hrs.**

INTRODUCTION

Issues and scope of Environmental BT. Interactions among soil microorganisms, biogeochemical role of soil microorganisms.

BIOACCUMULATION OF TOXICANTS

Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation

UNIT-II **12 Hrs.**

BIOLOGICAL TREATMENT OF WASTE WATER

Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration, ultrafiltration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries.

SOLID WASTE MANAGEMENT

Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules.

UNIT-III **10 Hrs.**

BIOLEACHING & BIOMINING

Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum.

BIOREMEDIATION:

Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.

UNIT-IV **Hrs.**

BIOTECHNOLOGY IN BIODIVERSITY CONSERVATION Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.

Text Books:

1. Mahopatra P K., "Textbook of Environmental Biotechnology", I K International Publishing House Pvt. Ltd, 2006
Indu Shekhar Thakur, Environmental Biotechnology Basic concepts & Applications, 2nd Edition, IK International Pvt. Ltd, 2015

Reference Books:

1. Bimal C. B and Rintu B., Environmental Biotechnology, Oxford University Press, 2023
Dubey R C and Maheshwari D K., "Text book of microbiology" 5th edition, S Chand and Company Ltd., 2022

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	3 (WK1 to WK4)	2 (WK1 to WK4)	2 (WK5)	1 (WK8)							3 (WK8)	2	3	2
CO2	3 (WK1 to WK4)	2 (WK1 to WK4)	3 (WK5)	1 (WK8)		2 (WK1, WK5, and WK7)	2 (WK9)				3 (WK8)	3	3	3
CO3	3 (WK1 to WK4)	2 (WK1 to WK4)	3 (WK5)	1 (WK8)		2 (WK1, WK5, and WK7)	2 (WK9)				3 (WK8)	3	3	3
CO4	3 (WK1 to WK4)	2 (WK1 to WK4)	3 (WK5)	1 (WK8)		2 (WK1, WK5, and WK7)	2 (WK9)				3 (WK8)	3	3	3

	Code	:	1BBTA402C	Biology For Engineers	Semester	: 4
	LTP	:	3:0:0		Course Type	: PCC
Hours/Sem.	Teaching	:	42Hrs.		CIE Marks	: 50
	Learning (TW+SL)	:	42Hrs.		SEE Marks	: 50
	Exam	:	6Hrs.		Total Marks	: 100
	Total Hrs.	:	90Hrs.		Credits	: 03

Professional Competency:

Understanding fundamentals of biological processes and apply to solve engineering problems, bridging the technical engineering with living systems.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Explain the structure and functions of cells and biomolecules, properties and applications of special biomolecules in engineering and industrial contexts.

CO2: Interpret bio-inspired models and natural mechanisms and correlate them with engineering designs and technological innovations.

CO3: Analyze the functional architecture of human organ systems as models to design and evaluate engineering solutions**.**

CO4: Apply the concept of bioprinting, artificial intelligence, and microbial processes in the design and development of innovative solutions for healthcare, food science, and sustainable infrastructure.

UNIT-I **10 Hrs.**

Introduction to Biology:

The cell: Structure, and functions of a cell. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, Proteins and Lipids. Importance of special biomolecules: Enzymes, vitamins and hormones -properties and functions.

Biomolecules and their Applications:

Carbohydrates in bioplastics production, Proteins in food production, Lipids in biodiesel.

UNIT-II **10 Hrs.**

Bio Inspiration Models Used in Engineering:

Bio inspiration - Introduction, Alliance between Engineering and Biology, Biomimicry - Science mimicking nature. Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Gecko Feet, Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train), Fire fly LED.

Nature Bioinspired Mechanisms:

BioEcholocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf), Respiration (MFCs) .

UNIT-III **12 Hrs.**

Human Organ Systems and Bio Designs

Brain as a CPU system -architecture, CNS and Peripheral Nervous System, signal transmission, EEG. Engineering solutions for Parkinson's disease.

Heart as a pump system -architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators.

Lungs as purification system gas exchange mechanisms, spirometry, Ventilators.

Eye as a Camera system, bionic eye. **Kidney** as a filtration system - dialysis systems.

UNIT-IV **Hrs.**

Trends In Bioengineering

Bioprinting techniques and materials, 3D printing of ear, bone and skin, electrical tongue and electrical nose in food science, Self-healing bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes), Biomining via microbial surface adsorption. Artificial Intelligence for disease diagnosis. Biochips & their applications. Biosensors & their applications.

Reference Books:

1. Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao, "Biology for Engineers" N Publishing, Bengaluru, 2023.
2. S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., *Biology for Engineers*, Tata McGraw-Hill, New Delhi, 2012.
3. Arthur T. Johnson, *Biology for Engineers*, 2nd Edition, CRC Press, Taylor & Francis Group, Boca Raton, FL, 2019.
4. Sohini Singh and Tanu Allen, *Biology for Engineers*, Vayu Education of India, New Delhi, 2014.
5. Yoseph Bar-Cohen, *Biomimetics: Nature-Based Innovation*, 1st edition, CRC Press., 2012
6. Ibrahim Ozbolat, *3D Bioprinting: Fundamentals, Principles and Applications*, Academic Press (Elsevier), 2016.
7. Rodríguez Méndez, M. L. (Ed.), *Electronic Noses and Tongues in Food Science*, 1st Edition, Academic Press (Elsevier), Cambridge, MA, USA, 2016.

Web links and Video Lectures (e-Resources)

- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Course Outcomes	Programme Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	2 (WK2, WK6)	2 (WK1,WK 5,WK7)	2 (WK9)	2			3 (WK8)	3	2	2
CO2	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	3 (WK1,WK 5,WK7)	2 (WK9)	2			3 (WK8)	3	2	2
CO3	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	3 (WK1,WK 5,WK7)	3 (WK9)	2			3 (WK8)	3	2	2
CO4	3 (WK1, WK2, WK3, and WK4)	3 (WK1, WK2, WK3, and WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	3 (WK1,WK 5,WK7)	3 (WK9)	2			3 (WK8)	3	2	2