Basaveshwar Engineering College, Bagalkote
Department of Biotechnology
Schemes of Teaching and Examination
2025-26
B. E. III SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			SAAE/ Sem		Examination Marks				Contact hour per sem
					L	T	P	Study Hours	Assignment/Quiz/ MCQs	Duration in hours	CIE	SEE	TOTAL	
1.	PCC	BBTA301C	Cell Biology & Genetics	03	3	0	0	42	6	3	50	50	100	90
2.	IPCC	BBTA302C	Microbiology	04	3	0	2	42	8	3	50	50	100	120
3.	IPCC	BBTA303C	Biochemistry	04	3	0	2	42	8	3	50	50	100	120
4.	IPCC	BBTA304C	Immunotechnology	04	3	0	2	42	8	3	50	50	100	120
5.	PCC	BBTA305C	Bioprocess Operations	03	3	0	0	42	6	3	50	50	100	90
6.	PCC	BBTA306C	Cell Culture Techniques	02	2	0	0	28	4	3	50	50	100	60
7.	PCCL	BBTA307L	Bioprocess Operations Lab	01	0	0	2	0	2	2	50	50	100	30
8.	MC	BHSA360M	Yoga-I	00	0	0	2	0	0	-	100	-	100	-
		BHSB360M	National Service Scheme (NSS)-I											
		BHSC360M	Physical Education-I											
		BHSD360M	Music-I											
Total				**21**	**17**	**0**	**10**				**450**	**350**	**800**	

Course Code:BBTA301C	CELL BIOLOGY & GENETICS	Credits : 03
Hours/ Week: (3 Hrs/week)		CIE Marks: 50
Total Hours of pedagogy (42Hrs)		SEE Marks : 50
Course Type: Theory		

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

REFERENCE 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.
3. 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

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 signalling, 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.

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3										1	3		
CO2	3	3									1	2		
CO3	3	3	2	1							1	3	2	
CO4	3	2	3	1							1	2	2	

Course Code:BBTA302C	MICROBIOLOGY	Credits: 04
Hours/ Week: L:T:P – 3:0:2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10Hours

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	12Hrs.

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.

REFERENCE BOOKS

1. Pelczar, Chan and Noel Kreig, 2010 “Microbiology”- 5th Edition Tata Macgraw Hill
2. Tortora, Funke and Case,2006,“Microbiology an Introduction” -8th Edition, Pearson Education.
3. E Alcamo I 2001. “Fundamentals of Microbiology”6th Ed, Jones & Bartlet, Pub.
4. Prescott, Harley & Klein,2008, “Microbiology” -7th Edition, WCB/McGraw Hill, Int. Edition.
5. Prescot and Dunn, 2002, “Industrial Microbiology”-Agribios India.

COURSE OUTCOMES

After completion of the course student will be able to:

1. Know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
2. Analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
3. Identify the causative organisms of the disease ,their control mechanisms and their effect on society
4. Analyze the applied techniques in the environment and create awareness to society

Course Outcomes	Program Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	2		2	3	2				3	2	2	3
CO2	3	2	2		2	2	1				2	2	2	3
CO3	3	2	2		2	2	2				3	2	2	3
CO4	3	3	2		2	3	3				2	3	3	3

Course Code:BBTA303C	BIOCHEMISTRY	Credits: 04
Hours/ Week: L-:T:P: 3:0:2		CIE Marks:50
Total Hours/Week : 05		SEE Marks:50

COURSE OBJECTIVES:

1. Analyze the concepts of biochemistry by relating biomolecular interactions for specific biological processes involving energetics.
2. Outline the major metabolic pathway of carbohydrates, lipid, amino acids and nucleic acids and their interconnections into its disorders.
3. Calculate and interpret energy changes in biochemical reactions
4. Identify and explain common techniques used in biochemical assay and research

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. Study of pH meter, Standard solutions: volume / weight and volume/volume measurements, 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 O-Toluidine method
5. Estimation of amino acid by ninhydrin method.
6. Estimation of DNA by Diphenyl amine method
7. Determination of iodine and acid value of lipids.
8. Estimation of proteins by Lowry's method.
9. Estimation of urea by Di Acetyl Monoxime method.
10. Estimation of iron by Wong's method.

REFERENCE BOOKS

1. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" 7th edition
2. W.H Freeman Co., Pub.
3. Lubert Stryer (2021)., "Biochemistry" -8th edition Freeman & Co., Pub.
4. Voet & Voet (2011). "Biochemistry"- 4th edition, John Wiley, New York Pub.
5. Thomas M. Davlins (2010). "Biochemistry with clinical correlations" 7th edition Wiley-Liss.
6. U. Sathyanarayana (2022). "Biochemistry" -5th edition, Books and Allied Pub.
7. Rodney Boyer, "Modern Experimental Biochemistry"-Pearson Education Pub, (2000).
8. Pattabhiraman, (2015). "Practical Biochemistry" 4th edition All India publisher and distributor.
9. Beedu Sashidhar Rao and Vijay Deshpande (2013) "Experimental Biochemistry" -I.K.Intl.
10. Plummer D. T (1988)."Practical Biochemistry" -TMH Pub.

COURSE OUTCOMES

After completion of the course student will be able to:

1. Interpret the basic concepts of biochemistry and metabolic pathways of the carbohydrates with their disorders and energetic of metabolic reactions.
2. 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.
3. Recognize the biosynthetic precursors involved in the amino acid metabolism and its disorders and interpret biochemical data, perform relevant calculations, and conclusions from experimental results.
4. Comprehend nucleic acid metabolism along with disorders and Present biochemical concepts clearly through written reports, presentations, or discussions using appropriate scientific language

Course Outcomes	Program Outcomes											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	3	-	3	-	3	-	-	-	3	3	3	3
CO2	3	3	3	-	3	-	3	-	-	-	3	3	3	3
CO3	2	3	3	-	3	-	3	-	-	-	3	3	3	3
CO4	3	3	3	-	3	-	3	-	-	-	3	3	3	3

Course Code:BBTA304C	IMMUNOTECHNOLOGY	Credits: 04
Hours/ Week: L: T: P - 3 : 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

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.

REFERENCE BOOKS

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology(8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

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.

Course Outcomes	Programme Outcomes											Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO1	3	2	2	1	3						3	3	3	
CO2	3	2	2	2	3						3	3	3	
CO3	3	3	3	2	3			1			3	3	3	2
CO4	3	2	2	2	3	2		1			3	3	3	2

Course Code:BBTA305C	BIOPROCESS OPERATIONS	Credits: 03
Hours/ Week: L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

FLUID FLOW OPERATIONS:

Biofluid Mechanics: Characteristics of fluid, Properties and Rheological behavior of fluids-Factors like (density and viscosity); Newton's Law of viscosity, Newtonian and Non-Newtonian fluids; Fluid statics-Pascal's law; Barometric equation and Pressure measurement using manometers (problems). Types of fluid flow: laminar and turbulent; Reynolds number and its Importance, velocity distribution in laminar flow and turbulent flow, aeration and agitation.

Basic equations of fluid flow: Continuity equation and Bernoulli theorem and equation; Derivation of Bernoulli's equation, Euler's equation, Correction for Bernoulli's equation.

Flow Measurement: Measurement of flow rate and velocity- Pitot tube and Pitot-static probe, variable head meters, variable area meters etc.

UNIT–II	12 Hrs.

HEAT TRANSFER OPERATIONS:

Conductive and Convective heat transfer: Modes of heat transfer, Conduction – Fourier's law of conduction, Thermal conductivity; Steady state heat conduction through uni-layer (slab/plane material) and multilayer (composite material/plane wall) and cylinder; Conceptual numericals on conduction; Convection- Forced and Natural convection, Concept of heat transfer coefficient- individual and overall; conduction-convection-conduction and the combined equation; Boiling and condensation heat transfer.

HEAT TRANSFER EQUIPMENT: Double pipe heat exchanger; Shell and Tube heat exchanger (with working principle and construction); Elementary design of Double pipe heat exchanger and Shell and Tube heat exchanger; Flow arrangements in Heat transfer equipment - co-current and counter-current flow; Concept of Log Mean Temperature Difference (LMTD); Conceptual numericals on LMTD

UNIT–III	10 Hrs.

MECHANICAL OPERATIONS: Filtration, Settling, Sedimentation, Screening, Flotation.

Separation of Solids:

Filtration: Types of Filtration, Distribution of overall pressure drop (Resistances), Filter medium, Characteristics of filter medium, Filter aids, Factors Affecting Rate of Filtration, Filtration equipment - Plate and Frame Filter Press, Rotary Drum Filter.

Theory of Settling: Types of Settling - Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity.

Sedimentation: Concept and Principle of Sedimentation, Batch Sedimentation process and Settling Velocity Curve, Sedimentation Equipment (cyclones, thickeners).

Screening: Concept and Importance of Screening Operations, Types of Screen Analysis, Average particle size determination, Effectiveness of a Screen.

Size Separation Based on Properties: Separation of Solid Particles from Liquid and Gas by Cyclones/Cyclone Separation, Froth Flotation, and Separation of Solid Particles based on Electrical and Magnetic Properties.

UNIT–IV	10 Hrs.

MASS TRANSFER OPERATIONS:

Diffusion: Fick's law of diffusion; Measurement of diffusivity; Types of diffusion; Steady-state molecular diffusion in fluids at rest and laminar flow; Mass transfer coefficients, and their correlations.

Mass Transfer in Bioreactors: Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas mass transfer; Theories of mass transfer, Gas-Liquid mass transfer, Measurement of KLa, Oxygen transfer methodology, Maximum cell concentration.

Concept of Mixing: Homogeneous and Heterogeneous Mixtures, Importance of Mixing and Agitation, Mixing liquids with liquids, Construction and Flow Patterns of Impellers, Mixing of Gases with Liquids

Separation Operations: Principles, mass transfer phenomenon in bioprocess operations like Extraction, Absorption, Adsorption and Desorption, Crystallization and Evaporation; Drying mechanism, drying curves, time of drying; batch and continuous dryers.

Distillation: Methods of distillation- Simple, Flash distillation and Fractional distillation of mixtures; McCabe Thiele method for estimation of number of trays.

REFERENCE BOOKS

1. McCabe W. L, Smith J. C and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008). Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
3. Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA. Edited by R. P. Chabra, V. Shankar (2017).
4. Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA. Edited by R. P. Chabra and Basavaraj Gurappa (2019).

COURSE OUTCOMES

After completion of the course student will be able to:

1. Apply the knowledge of the fluid mechanics during the analysis of fluids and flow rates
2. Competent to handle heat transfer operations and instruments in the bioprocess industry.
3. Apply the skills of mechanical operations in real-time bioprocess applications
4. Competent to analyze and apply mass transfer operations for separation of bio-products in bioprocess industries.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	2	1	2	-	-	-	-	-	3	3	2	2
CO2	3	3	3	2	2	-	-	-	-	-	3	3	2	2
CO3	3	3	3	3	2	-	-	-	-	-	3	3	2	2
CO4	3	3	3	3	2	-	-	-	-	-	3	3	2	2

Course Code: BBTA306C	CELL CULTURE TECHNIQUES	Credits: 02
Hours/ Week: L: T: P - 2: 0: 0		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

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	6 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	6 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.

REFERENCES BOOKS

1. Culture of Animal cells-3rdEdition-R.IanFreshney.Wiley Less, 2010
2. Introduction to Plant biotechnology by H. S. Chawla, 2nd Edition, Oxford and IBH Publishers, 2010
3. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers, 2010.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS publishers, 2002

COURSE OUTCOMES

After completion of the course student will be able to:

1. Apply the fundamental principles, laboratory setup, media components, sterilization techniques, and the role of plant growth regulators in plant cell culture.
2. Apply various plant tissue culture techniques for crop improvement.
3. Analyze animal cell culture techniques including cell line establishment, subculturing, and media formulation, and analyze the use of antibiotics and enzymes in cell culture.
4. Evaluate cell viability, cytotoxicity, and contamination in cultured cells using appropriate assays in animal cell culture research.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO 1	3	2	1	1	1	2	-	-	-	-	2	3	3	2
CO 2	3	3	2	2	2	2	-	-	-	-	2	3	3	2
CO 3	3	2	2	2	2	2	-	-	-	-	2	3	3	2
CO 4	3	3	2	3	2	2	-	-	-	-	2	3	3	2

Course Code: BBTA307L	BIOPROCESS OPERATIONS LAB	Credits :1
Hours/ Week: L:T:P 0-0-2		CIE Marks: 50
Total Hours / Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS

1. Verification of Bernoulli's theorem and equation
2. Venturimeter and Orifice meter
3. Conduction in multi-layer slab (Composite material)
4. Natural convection
5. LMTD calculation in the heat exchanger (Co-current) and calculation of LMTD and over all heat transfer coefficient (Counter-current)
6. Batch sedimentation
7. Settling of Particles (Terminal settling velocity)
8. Size Separation- Sieve analysis (Differential analysis) and Screen Effectiveness (Cumulative analysis)
9. Extraction
10. Drying and Distillation

REFERENCE BOOKS

1. Unit operations in Chemical Engineering, Warren L. McCabe, Julian, C. Smith & Peter Harriot, McGraw-Hill Education (India) Edition, 2014.
2. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C. W. Clump, L. Maus, and L. B. Anderson John Wiley & Sons, 2nd edition, 2008.
3. Unit Operations of Chemical Engineering, Vol I & II Chattopadhyaya Khanna Publishers, Delhi-6 1996.
4. Fluid Mechanics, K L Kumar S Chand & Company Ltd, 2008.
5. Introduction to Chemical Engineering, Badger W.I. and Banchero, J.T., Tata McGraw Hill New York. 1997.
6. Heat Transfer J P Holman Mc Graw Hill International Ed., 10th Edition, 2010.

COURSE OUTCOMES

After completion of the course, students will be able to

1. Apply the knowledge of the fluid mechanics during the analysis of fluids and flow rates.
2. Operate heat transfer operations and instruments in the bioprocess industry.
3. Apply the skills of mechanical operations in real-time bioprocess applications.
4. Analyze and apply mass transfer operations for separation of bioproducts in bioprocess industries.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	2	1	2	-	-	-	-	-	3	3	2	2
CO2	3	3	3	2	2	-	-	-	-	-	3	3	2	2
CO3	3	3	3	3	2	-	-	-	-	-	3	3	2	2
CO4	3	3	3	3	2	-	-	-	-	-	3	3	2	2

B. E. IV SEMESTER
2025-26

Sl. No.	Category	Subject Code	Subject Title	Credits	Hours/ Week			SAAE/ Sem		Examination Marks				Contact hour per sem
					L	T	P	Study Hours	Assignment/ Quiz/ MCQs	Duration in hours	CIE	SEE	TOTAL	
1.	IPCC	BBTA401C	Biostatistics & Tools	04	3	0	2	42	8	3	50	50	100	120
2.	IPCC	BBTA402C	Upstream Processing Technology	04	3	0	2	42	8	3	50	50	100	120
3.	PCC	BBTA403C	Bioprocess Principles and Calculations	03	3	0	0	42	6	3	50	50	100	90
4.	IPCC	BBTA404C	Molecular Biology	04	3	0	2	42	8	3	50	50	100	120
5.	BSC	BBTA405C	Biology for Engineers	03	3	0	0	42	6	3	50	50	100	90
6.	UHV	BHSA424C	UHV-II	01	1	0	0	14	2	2	50	50	100	30
7.	MC	BHSA460M	Yoga-II	00	0	0	2	0	0		100	-	100	
		BHSB460M	National Service Scheme(NSS)-II											
		BHSC460M	Physical Education -II											
		BHSD460M	Music-II											
Total				**19**	**16**	**0**	**08**				**400**	**300**	**700**	

Course Code: BBTA401C	BIOSTATISTICS & TOOLS	Credits: 04
Hours/ Week: L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

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).

COURSE OUTCOMES

After completion of the course student will be able to:

1. Analyze the data using various statistical tools in the field of research and industry.
2. Investigate the probability distributions of the data.
3. Apply the knowledge of inferential statistics to analyze the data using statistical tools.
4. Design and analyze the experimentation using statistical software tools for the field of research and industry.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	2	3	3	-	-	-	-	-	3	3	3	-
CO2	3	3	2	3	3	-	-	-	-	-	3	3	3	-
CO3	3	3	3	3	3	2	-	-	-	-	3	3	3	-
CO4	3	3	3	3	3	2	-	-	-	-	3	3	3	2

Course Code: BBTA402C	UPSTREAM PROCESSING TECHNOLOGY	Credits: 4
Hours/ Week: L: T: P – 3-0-2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10 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	12 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 bioproduct
11. Analysis of biomolecules/bioactive compounds by HPLC.

REFERENCE 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. Introduction to plant Biotechnology by H.S. Chawla, Second edition, Oxford & IBH Publisher
4. Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996). Elsevier
5. Culture of animal cells by Ian Freshney 4th Edition. John Willey & Sons Publ.
6. Animal Biotechnology by Murray Moo-Young (1989), Pergamon Press, Oxford.

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.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO 1	3	1										1	3	
CO 2	-	3											3	3
CO 3	2	2	3	1	1					2	1	3	3	
CO 4	2									3	1		3	

Course Code: BBTA403C	BIOPROCESS PRINCIPLES AND CALCULATIONS	Credits-03
Hours/ Week: L:P:T- 3:0:0		CIE Marks: 50
Total Hours: 40		SEE Marks: 50

UNIT –I	12 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.

INTRODUCTION TO BIOPROCESSES:

Bioprocess Engineering, Role of a bioprocess engineer in the biotechnology industry, unit operations involved in bioprocesses.

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	10 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.

REFERENCES BOOKS

1. Chemical Process Calculations by D. C. Sikdar, PHI Learning Private Limited, Delhi, 2013.
2. Stoichiometry by B. I. Bhatt and S. M. Vora, Tata McGraw-Hill Publishing, 4th Edition, 2004.
3. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI Learning Private Limited, 2005.
4. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press, 2012.
5. Biochemical Engineering Fundamentals: by J. E. Bailey & D. F. Ollis, McGraw-Hill, 2005.
6. Bioprocess Engineering by Shule and Kargi, Prentice Hall, 2010.

COURSE OUTCOMES

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

1. Solve Basic Biochemical Calculations involving compositions of Mixtures and solutions.
2. Apply the knowledge of Material Balances and solve the Bioprocess Engineering Problems involving Unit Operations.
3. Apply the knowledge of Material Balances and energy balance to solve the Bioprocess Engineering Problems involving Unit Processes.
4. Analyse the Bioprocess Engineering problems by applying the Stoichiometry knowledge of Microbial cells used for the production of bioproducts.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	2	1	1	-	-	-	-	-	3	3	2	1
CO2	3	3	3	2	1	-	-	-	-	-	3	3	2	1
CO3	3	3	3	2	1	-	-	-	-	-	3	3	2	1
CO4	3	3	3	2	1	-	-	-	-	-	3	3	2	1

Course Code: BBTA404C	MOLECULAR BIOLOGY	Credits-4
Hours/ Week: L: T: P - 3 : 0: 2		CIE Marks : 50
Total Hours/week : 05		SEE Marks : 50

UNIT – I	12 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 & Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).

UNIT – II	10 Hrs.

TRANSCRIPTION

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

TRANSLATION

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

UNIT – III	10 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 Zippers.

UNIT – IV	10 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 recombination, Mechanism of recombination-homologous (Holliday model), site specific recombination.

LIST OF EXPERIMENTS

1. Callus Induction Technique- Stock preparation, Media preparation.
2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus
4. Study of absorption spectra of nucleic acids.
5. UV-Vis survival curve of bacteria.
6. Agarose gel electrophoresis.
7. Isolation of genomic DNA from plant sources.
8. Isolation of plasmid DNA from E. coli.
9. Estimation of RNA by orcinol method.
10. Purity of nucleic acids by UV-Vis Spectrophotometer.
11. Standard Operating Procedure for Centrifuge and Gel Documentation Unit.

REFERENCE BOOKS

1. David Nelson and Michael Cox, (2017), Lehninger Principles of Biochemistry (6th Edition), W.H. Freeman
2. James Watson (2008), Molecular Biology of the Gene (5th Edition) Pearson Education
3. David Freifelder, (2008), Essentials of Molecular Biology (2nd Edition), Narosa Publishing House
4. Sadashiva and Manickam, (2017), Biochemical Methods (2nd Edition), W.H. Freeman
5. H. S. Chawla, (2010),Introduction to Plant biotechnology(2nd Edition), Oxford and IBH Publishers,
6. Sambrook & Russell, (2002), Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab.

COURSE OUTCOMES

After completion of the course student will be able to

1. Analyze the basic aspects of replication and apply the knowledge of practical aspects in various molecular biology based applications.
2. Acquire working knowledge on the mechanism of transcription, translation and post translational processes along with their applications in research.
3. Apply research-based knowledge of gene regulation mechanism in prokaryotes and eukaryotes in the field of Biotechnology.
4. Select and apply the steps of transposition, Proto-oncogenes conversion and molecular mechanism of genetic recombination in treating diseases.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	2	2	2	1	2	-	-	-	-	3	2	2	2
CO2	2	2	2	2	3	2	-	-	-	-	3	2	3	2
CO3	2	2	2	3	3	2	-	-	-	-	3	2	3	2
CO4	2	2	3	3	3	2	-	-	-	-	3	2	3	2

Course Code: BBTA405C	BIOLOGY FOR ENGINEERS	Credits-3
Hours/ Week: L:P:T-3:0:0		CIE Marks: 50
Total Hours: 42		SEE Marks: 50
		Total Marks: 100

Course objectives:

- To familiarize the students with the basic biological aspects.
- To enable the students to apply biological concepts for engineering applications.
- To show the students how nature and biological systems inspire building sustainable solutions and technologies.
- To motivate the students to develop the interdisciplinary vision of biological engineering.

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 cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, Lipids in biodiesel, Enzymes in biosensor fabrication, food processing, detergent formulation and textile processing.

UNIT-II	12 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 MATERIALS AND MECHANISMS:

BioEcholocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf), Respiration (MFCs) Human Blood substitutes-hemoglobin based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

UNIT-III	10 Hrs.

HUMAN ORGAN SYSTEMS AND BIO DESIGNS

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. 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, Heart-lung machine).

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

UNIT-IV	10 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.

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

REFERENCE BOOKS

1. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.

2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
3. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
4. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
5. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
6. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
7. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
8. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

COURSE OUTCOMES

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

1. Elucidate the basic biological concepts required for engineering applications.
2. Apply nature inspired concepts for domain specific applications.
3. Analyze and apply the principles of bioengineering in developing biomedical devices.
4. Apply the innovative biobased solutions for eco-friendly and socially relevant problems.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO 1	3	3	2	2	2						3	3	2	2
CO 2	3	3	2	2	3						3	3	2	2
CO 3	3	3	2	2	3						3	3	2	2
CO 4	3	3	2	2	3						3	3	2	2