JSS MAHAVIDYAPEETHA

JSS SCIENCE & TECHNOLOGY UNIVERSITY, MYSURU

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

SYLLABUS III & IV SEMESTER: 2017-2018

DEPARTMENT OF BIOTECHNOLOGY

Syllabus of Teaching and Examination for B.E (Biotechnology)

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	BIOCHEMISTRYBT310
No. of Teaching Hours – 52	Credits : 4:0:0 L-T-P
CIE Marks : 50	SEE Marks: 100

Prerequisites: Students should have the basic knowledge of Chemistry, Physics and CellBiology.

Course objective:

The objective of the course is to

1. The course introduces the students to the fundamentals of chemistry of life.
2. The course imparts knowledge on chemistry of biomolecules like carbohydrates, amino acids, proteins, lipids and nucleic acids.
3. The course emphasizes on the functions of these biomolecules
4. The course explains the importance of vitamins, hormones and water and their associated disorders.
5. The course correlates the biomolecules and their biotechnological applications

Course outcomes:

After the completion of the course students will be able to

CO-1 Outlines the basic principles of Biochemistry

CO-2 Define and classify Biomolecules

CO-3 Relate the structure and functions of Biomolecules

CO-4 Summarize the role and importance of Biomolecules in human life and their use.

CO-5 Distinguish the importance of vitamins, minerals, Hormones and water and their associated disorders.

UNIT 1: CARBOHYDRATES AND POLYSACCHARIDES **12 Hours**

Classification- monosaccharides, disaccharides and polysaccharides, configurational and conformational aspects of carbohydrates. Structure, properties and importance of homo and hetero-polysaccharides. Blood group

polysaccharides, bacterial and plant polysaccharides, Glycoproteins.

UNIT 2: AMINO ACIDS AND PROTEINS **10 Hours**

Classification, Acid-base properties of amino acids. Non-protein amino acids. Peptide bond –Structure and conformation. Structure of proteins-Primary, secondary, tertiary and quaternary. Peptide synthesis – Merrifield solid phase synthesis. Naturally occurring peptides. Structure of Insulin, Ribonuclease and Myoglobin. Quaternary structure – Hemoglobin. Denaturation of Proteins.

UNIT 3: FATTY ACIDS AND LIPIDS **10 Hours**

Classification of lipids , Types of fatty acids, triglycerides, chemistry, structure and biological activity. Acyl glycerols, phospholipids, sphingolipids, glycolipids, lipoproteins, steroids, prostaglandins, thromboxanes and leukotrienes.

UNIT 4: NUCLEIC ACIDS **10 Hours**

Structure and properties of nucleosides and nucleotides. Properties of nucleic acids in solution, melting of the double helix and hyperchromicity. Primary, secondary and tertiary structure of DNA, tRNA. DNA polymorphism.

UNIT 5: VITAMINS , MINERALS, HORMONES AND WATER

Vitamins and Minerals: Definition, Chemistry, Sources, Requirements, Biological action and Deficiency leading to disorders.Hormones: Definition, types and biological functions, Hypo and Hyper secretions.Water – Structure and properties

TEXT BOOKS:

1. David L Nelson & Michael M. Cox, A.Lehninger, (2006) Principles of Biochemistry, Macmillan Work Publishers.

2. LubertStryer, (2007), Student Companion to Stryer's Biochemistry, W H Freeman &Co.,San Francisco

REFERENCE BOOKS:

1. Voet&Voet, (2008), Fundamentals of Biochemistry: Life at the Molecular Level, John Wiley New & Sons.

2. Albert Lehninger, (2010), Principles of Biochemistry, W.H. Freeman & Company.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	CELL BIOLOGY AND GENETICS BT320
No. of Teaching Hours – 52	Credits : 4:0:0 L-T-P
CIE Marks : 50	SEE Marks : 100

Prerequisites: Students should have the fundamental knowledge of biology.

Course objectives: The objectives of this course is

1. To give an overview of prokaryotic and eukaryotic cells, morphology of its organelles and to understand the structure and function relationship of each organelle.
2. To study cell to cell communication through receptors, different forms of signaling at various stages of growth and development s in animals and plants.
3. To understand the processes of cell cycle and its regulation, cell division in somatic and germline cells; mitosis and meiosis and steps involved in cell death.
4. To state the basic principles of Genetics, Mendel's laws of inheritance, to solve simple genetic problems and interaction of genes.
5. To learn the role of chromosome in inheritance, analyse the causes of sex determination in various organisms, to use pedigree to infer inheritance and to study chromosomal aberrations.

Course outcomes:

After successful completion of this course, students would be:

CO-1 Able to outline the structure of a cell, differentiate between the prokaryotic and eukaryotic cell components and to relate the structure and function of all cell organelles.

CO-2 Able to differentiate between different receptors types, their classes and role in cell to cell communication both in animals and plants,

CO-3 Able to describe the stages in cell cycle and its regulation, mitosis and meiosis, analyze the relationship between mitosis and meiosis, and steps involved in apoptosis

CO-4 Able to explain different laws of Mendalism, compare expression of those traits that do not obey Mendalism with examples.

CO-5 Able to identify different inheritance patterns, sex linked diseases, analyse pedigree and summarize chromosomal aberrations, their exploitation with an overview of evolution and epigenetics.

UNIT 1: CELL AND ITS ORGANELLES

Introduction to concept of cell, differentiating prokaryotic and eukaryotic cell details: plant and animal cell. Structural organization and functions of: cell wall and membrane, endoplasmic reticulum, mitochondria, Golgi complex, chloroplast, ribosomes, lysosomes, peroxisomes, cytoskeletal structures - Microtubules, Microfilaments and Intermediate filaments, nucleus and its composition: Nucleoplasm, nucleolus, chromatin material, Chromosomes morphology, classification and packaging of chromatin material,

10 Hours

UNIT 2: CELL COMMUNICATION

General principles of cell communication, receptors and their role in signaling, signaling through G-protein linked cell surface receptors, enzyme linked cell surface receptors and ion channel linked receptors. Signaling in plants: Response to environment, stimuli and signaling mechanism through plant growth regulators, ethylene receptors, phytochromes.

10 Hours

UNIT 3: CELL DIVISION AND PROGRAMMED CELL DEATH

Cell cycle and its regulation, mitosis and meiosis, programmed cell death, function of caspase protein in cell death, activation of procapsaes. Externisic and intrinsic signaling pathways in apoptosis.

10 Hours

UNIT 4: INTRODUCTION TO GENETICS

Mendelism: Mendel's work, laws of heredity, test cross, monohybrid and dihybrid crosses, law of segregation and independent assortment, simple Mendalian problems. Exceptions to Mendelism: Incomplete Dominance, interaction of genes: supplementary genes-comb pattern in fowls, complementary genes -flower colour in sweet peas, epistasis-plumage colour in poultry,

coatcolour in mice and dogs, multiple factors - skin colour in human beings, multiple allelism-blood groups in human beings.

10 Hours

UNIT 5: INHERITANCE AND CHROMOSOMAL VARIATIONS

Sex chromosomes and inherited diseases: chromosomes, concepts of allosomes and autosomes. Sex determination in plants and XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals.Sex linked inheritance: hemophilia and color blindness, cytoplasmic Inheritance: plastid inheritance in *Mirabilis jalapa*, and Shell coiling in*Limnaea*, Pedigree analysis, Linkage and crossing over:types of linkage and crossing over. General account of structural and numerical chromosomal aberrations (Autosomal and allosomal) with examples. Mutations: Types, mutagens: physical and chemical, molecular basis of mutation. Mutations in plants, animals, and microbes for human welfare, genetic variation and mutation as a tool in evolution and speciation and an overview of epigenetics.

12 Hours

TEXT BOOKS

1. Verma and Agarwal (2008) Cell Biology, Genetics, Molecular Biology and Evolution, S Chand publishers

REFERENCE BOOKS

1. Alberts B et al., (2012) Molecular biology of the cell, 8th edition, Taylor and Francis group,NY.

2.Benjamin A Pierce (2012) Genetics, A conceptual approach, 4th Edition, W. H Freeman and Company, NY

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**MICROBIOLOGY BT330**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Pre-requisite: Student should have broad knowledge of Biology and fundamentals of chemistry and Physics.

Course Objectives:

1. The course introduces the students to the fundamentals of Microbiology, its history, diversity, variants of Microscopy, culturing and control of different groups of Microorganisms.
2. The course imparts knowledge on various groups of Microorganisms.
3. The course explains the nutritional requirements, assessment on growth and genetics of Microorganisms.
4. The course provides opportunity to understand various Microbial diseases, their spread and management.
5. The course highlights the role played by Microorganisms in Food and Fermentation Industries.

Course OutScomes:

After successful completion of this course, students would be:

CO-1 Define and develop an understanding underlying the basic principles of Microbiology, Demonstrate appropriate laboratory skills in isolation and identification of microorganisms and also perform aseptic techniques to control them

CO-2 Differentiate different groups of microorganisms based on Morphology, Function and Reproduction

CO-3 Evaluate the Physiological and genetic characteristics of Microorganisms.

CO-4 Recognize the role of different microorganisms in causing diseases and understand their control and management

CO-5 Explain the impact of Microorganisms in Food and other associated industries.

UNIT 1: INTRODUCTION

Overview: The scope and relevance of Microbiology, History and development of Microbiology,Prokaryotes and Eukaryotes, Types of Microorganisms, Microbial diversity and Taxonomy

Microscopic Examination: Bright-field Microscopy, Dark-field Microscopy, Phase-ContrastMicroscopy, Fluorescence Microscopy, and Electron Microscopy.

Microbial Techniques: Pure culture techniques, staining of microorganisms, Enumeration ofmicroorganisms. Characterization of microorganisms

Sterilization Techniques: Heat, Steam, Radiation, Filtration and Chemical.

12 Hours

UNIT 2: STRUCTURE, FUNCTION AND REPRODUCTION OF MICROORGANISMS

Bacteria: Morphology, ultra structure and reproduction. **Viruses:** Morphology, types ofsymmetry, lytic and lysogenic cycle. Prions. **Fungi:** Morphology, ultra structure and reproduction, **Algae:** Morphology, ultra structure and reproduction,

10 Hours

UNIT 3: MICROBIAL PHYSIOLOGY & GENETICS

Microbial Nutrition: Common nutrient requirements, culture media,

Microbial growth: The growth curve, factors affecting growth, measurement of growth.

Bacterial genetics: Study of microbial genetics, Inheritance, Bacterial recombination,conjugation, transduction and transformation.

10 Hours

UNIT 4: MEDICAL MICROBIOLOGY

Common Microbial diseases and their control

Bacterial: Typhoid, Tuberculosis, Cholera, Leprosy, Syphilis, and Diarrhea

Viral: AIDS, Hepatitis, SARS, Polio, and Rabies.

Fungal: Candidiasis, Mycoses. **10 Hours**

UNIT 5: FOOD AND INDUSTRIAL MICROBIOLOGY

Importance of bacteria, yeast and moulds in food, Food spoilage and preservation, Microbiology of fermented food products.

Strain selection, improvement and preservation of industrially important microbes, Major industrial products.

10 Hours

TEXT BOOKS:

1. Prescott, Harley and Klein, 2004, Microbiology**,** WCB McGraw-Hill Publishers.
2. Pelczar, Chan and Krieg, 1998, Microbiology, TATA McGraw-Hill Publishers.

REFERENCE BOOKS:

1. Stainer, R. L. Ingram, J. L. and Wheelis, M. L. 2007, General Microbiology, Macmillan Press Ltd.
2. Prescott and Dunn, 2006, Industrial Microbiology, WCB McGraw-Hill Publishers

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**MOMENTUM TRANSFER AND MECHANICAL OPERATIONS BT340**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Prerequisites: Students should have the basic knowledge of engineering Mathematics, Physics, Chemistry and elements of Mechanical engineering.

Course objective:

1. To introduce fundamental principles of fluid mechanics, and mechanical operations used in Bioprocess industries.

2. To Provide fundamental concepts of fluid statics and fluid dynamics

3. To introduce Engineering problems related to fluid pressure, flow through pipes and channels, transportation and metering of fluids

4. To provide an overview of the approaches, methods and techniques of different mechanical Operations that are used in bioprocess industry for size separation and reduction.

5. To provide different mechanical operations those are used in solid liquid separation.

Course outcomes:

After completing the course students will able to

CO-1 Develop correlations between process variables using dimensional analysis

CO-2 Acquire knowledge related to fluid statics and dynamics, transport of fluids and flow measurements.

CO-3 Adapt the concepts developed for fluid flow analysis to issues in bioprocessing.

CO-4 Identify suitable physical operations for size reduction that has to be used in bioprocess industry.

CO-5 Identify and use suitable solid liquid separation technique that are to be used in bioprocess industry by mechanical means

UNIT 1: INTRODUCTION AND RHEOLOGY OF FLUIDS

Concepts of Unit Operations and Unit Processes. Units and dimensions. Basic and derived units. Dimensional homogeneity. Dimensionless numbers. Similitude: geometric, dynamic and kinematics criteria. Rayleigh's method, Buckingham's pi theorem. Newtonian and Non Newtonian fluids. Power law model, Maxwell's model and viscous models. Time dependent and time independent models.

10 Hours

UNIT 2: FLUID FLOW:

Fluid Definition. Pressure measurements, manometric equations, different types of monometers. Reynolds number, types of flow**.** Continuity and Bernoulli's equations, Euler's equation. Flow through circular and non circular conduits. Hagen Poiseuille equation. Losses through pipe and fittings, flow through stagnant fluids. Free and hindered settling, Stoke's law, Newton's law, terminal settling velocity and sedimentation. Flow past immersed bodies- drag, drag coefficient. Kozney-karmen equation. Fluidization. **12 Hours**

UNIT 3: FLUID PUMPING AND METERING:

Pipe and pipe fittings. Flow measurements: Orifice meter, venture meter, Rotometer, pitotube, notches, weirs and other flow measuring techniques. Energy calculations. Pumps: Centrifugal and reciprocating pumps, characteristics of centrifugal and reciprocating pumps. Valves, steam traps, pressure regulators, Pressure gauges. Numerical problems. **10 Hours**

UNIT 4: MECHANICAL OPERATIONS1:

Size reduction, sieve analysis. Sedimentation, sedimentation equipment. Mixing: types of mixers, power number and power consumptions in mixing operations. **10 Hours**

UNIT 5: MECHANICAL OPERATIONS2:

Sedimentation ,Filtration: filtration equipment, constant rate and constant pressure filtration. Centrifugation: Types of centrifuges and Numerical problems. Sedimentation

10Hours

TEXT BOOKS:

1. Elements of Chemical Reaction Engineering by H. S. Fogler, New Jersey, 2009

REFERENCE BOOKS:

1. Elementary Principles Of Chemical Processes by R. M. Felder And R. W. Rousseau, Wiley India Pvt. Ltd., New Delhi., 2010

2. Coulson And Richardson's Chemical Engineering, Volume 2 by J. M. Coulson, J. F. Richardson, J. R. Backhurst And J. H. Harker, Elsevier India, 2006

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**BIOCHEMISTRY LAB BT35L**
No. of Teaching Hours – 39	**Credits : 0:0:2 L-T-P**
CIE Marks : 50	**SEE Marks : 50**

Prerequisites: Students should know basic biology and theoretical concepts of Biochemistry

Course objective: The objective of this course is:

1. To train the students in the skills of characterization of biological molecules.

Course outcomes:

After completing the course students will able to

CO-1 Determine an experimental objective and design experiments for estimation of biomolecules.

CO-2 To learn the skills is handling qualitative and quantitative bioassays and their relationship.

List of experiments

1. Preparation of molar/normal solutions and Buffers – Acetate, Phosphate and Tris-HCl Buffers (any one).
2. Paper chromatography for sugars and amino acids – Ascending, Descending and Circular chromatography
3. Qualitative tests for carbohydrates, amino acids, proteins and lipids
4. UV-Absorption spectra of proteins and nucleic acids.
5. Estimation of reducing sugar by DNS method.
6. Estimation of protein by Lowry's method.
7. Determination of oil/fat content
8. Determination of Iodine value of a lipid.
9. Determination of saponification value of lipids.

10. Separation and estimation of casein from milk.
11. Preparation of Lecithin from egg-yolk.
12. Determination of molecular extinction coefficient.
13. Estimation of Ascorbic acid.
14. Estimation of phenols.
15. Estimation of iron from hemoglobin.

TEXT BOOKS

1. Keith Wilson, 2007, Principles and Techniques of Practical Biochemistry, Cambridge University Press

2. P.B. Hawk , B.L. Oser(Ed), 2008, Physiological Chemistry, McGraw-Hill Education.

REFERENCE BOOKS

1. Plummer David T, 2009, Introduction to Practical Biochemistry, Tata Mgraw Hill.

2. Rodney F. Boyer, 2007, Modern Experimental Biochemistry, Prentice Hall.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**CELL BIOLOGY AND GENETICS LAB BT36L**
No. of Teaching Hours – 39	**Credits : 0:0:2 L-T-P**
CIE Marks : 50	**SEE Marks : 50**

Prerequisites: Students should know basic biology and theoretical concepts of cell Biology and genetics

Course objective: The objective of this course is:

1. To give practical experience in understanding different cell structure, its organelles and multiplication
2. To learn the laws of heredity with practical emphasis on inheritance

Course outcomes:

After completing the course students will able to

CO-1 Identify different types of eukaryotic cells, their multiplication

CO-2 Isolation of genetic material, its inheritance, analysis of karyotype and pedigree.

List of experiments

1. Principle and utility of microscopy.
2. Observation of distinguishing features of different eukaryotic cells.
3. Measurement of stomatal cells
4. Preparation of blood smear and differential staining of blood cells.
5. Identification of Blood groups
6. Study of divisional stages in Mitosis.
7. Study of divisional stages in Meiosis.
8. Isolation of plant cellular DNA.
9. Observation of growth and differentiation in single cells.

10. Isolation of chloroplasts.

11. Simple genetic problems solving

12. Human Karyotype analysis

13. Simple Mendelian traits in humans and pedigree analysis.

REFERENCE BOOKS

1. Alberts B et al., (2012) Molecular biology of the cell, 8th edition, Taylor and Francis group, NY.

2.Benjamin A Pierce (2012) Genetics, A conceptual approach, 4th Edition, W. H Freeman and Company, NY

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**MICROBIOLOGY LAB BT37L**
No. of Teaching Hours – 39	**Credits : 0: 0:2 L-T-P**
CIE Marks : 50	**SEE Marks : 50**

Course objective:

To impart expertise in isolation, identification and maintenance of microorganisms. The course trains students in handling, aseptic conditions and growing industrially important microorganisms.

Course outcomes:

After completing the course students will able to

CO-1 Identify different techniques involved in handling microorganisms

CO-2 Isolation, Identification, characterization and control of different microorganisms.

List of experiments:

1. Aseptic techniques: Methods of sterilization.
2. Media preparation, plugging and plating techniques.
3. Handling and care of microscopes (Stereo and Biocular)
4. Isolation of bacteria from soil by serial dilution and agar plating technique.
5. Isolation and identification of fungi from seeds by blotter method.
6. Enumeration of total count and viable count of bacteria from milk.
7. Growth curve of bacteria.
8. Staining of bacteria: Simple staining, differential staining and negative staining.
9. Antibiotic susceptibility test of bacteria.
10. Biochemical tests of microorganisms
11. Preservation and handling of microbial strains.
12. Alcoholic fermentation (Demo).
13. Electron microscope (Demo).

TEXT BOOKS:

1. James.G. Cuppuccino and Natalie Sherman,(1991)**,** Microbiology laboratory, Dorling Kindersley (India) Pvt Ltd.
2. Aneja, K.R. (1994), Microbiological techniques, New Age Publishers.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**ADVANCED PROGRAMMING LANGUAGE (LINUX AND PERL) BT410**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Prerequisites: Students should have the basic knowledge of computer and programminglanguage

Course objective:

The objective of the course is to introduce basics of operating systems, handling data and Mat Lab. These have wide applications in Biotechnology.

Course outcomes:

After completing the course students will able to

CO 1 Describe the concepts of operating system.

CO-2 Describe the concept of process management and DBMS

CO-3 Demonstrate the usage of operators and control structures of PERL.

CO-4 Implement the usage of arrays and demonstrate the pattern matching concepts of PERL through programming.

CO 5 Describe the concepts of BIOPERL and demonstrate its usage of MATLAB.

UNIT 1: INTRODUCTION TO OPERATING SYTEM

Introduction to Operating Systems, Main frame systems- Batch systems, Multi-programmed systems and Time shearing systems, Distributed systems—Client-Server Systems and Peer-to-Peer Systems, desktop systems , multiprocessor system, real time system, Computing environment.

10 Hours

UNIT 2: PROCESS MANAGEMENT AND BASICS OF DATABASE

Process concept, process scheduling, co-operating processes, inter process communication, threads overview, multi threading, critical selection problem. Semaphors and dead locks. Introduction to flat files, DBMS and RDBMS, E-R relationship. Introduction to SQL, basic commands, using SQL in MS access, creating and modifying tables, joining tables, simple queries using SQL, inner join, outer join, data sorting, filters.

10 Hours

UNIT 3: INTRODUCTION TO PERL

OVERVIEW OF PERL**:** getting started, Documentation in Perl, Numerical data types, conversion between numbers & strings. Operators in Perl (arithmetical operator, bit wise, logical, Boolean, string operator, and operator precedence). Control structures in Perl, built in data types, special variables, and regular expression variables.

08 Hours

UNIT 4: ARRAYS AND PATTERN MATCHING

ARRAYS: Introduction, changing array size, interacting over an array by reference. Extracting unique elements from a list. Computing union, intersection or difference of unique list.. Appending one array to another, reversing an array, processing multiple elements of an array, finding sum of all elements in an array.

PATTREN MATCHING: Introduction, matching letters, matching words, finding the nth occurrence of a match, matching multiple lines, Reading records with a pattern separator, extracting a range of lines, expressing AND, OR, NOT in a single patterns, matching multiple byte characters, matching a valid mail address, matching abbreviations

12 Hours

UNIT 5: BIOPERL AND MATLAB

Overview, Bioperl objects, brief descriptions (Seq, PrimarySeq, LocatableSeq, RelSegment, LiveSeq, LargeSeq, RichSeq, Seq with Quality, SeqI), Location objects, Interface objects and implementation objects, representing changing sequences (LiveSeq), Using Bioperl : accessing

sequence data from local and remote databases, accessing remote databases(Bio::DB::GenBank, etc), Indexing and accessing local databases Bio::Index::*, bp_index.pl,bp_fetch.pl, Bio::DB::*), Transforming sequence files (SeqIO), Transforming alignment files (AlignIO).

Introduction to MATLAB, features of MATLAB toolbox, introduction to Excel, Excel spread sheets utilities, and operations. Usage of MATLAB and Excel towards biostatistical applications, usage of toolboxes towards biochemical applications.

12 Hours

TEXT BOOKS;

1. Abraham Silberschatz , Peter Baer Galvin and Greg Gagne**, (**2003), Operating System Concepts, 4th edition
2. Randal, L. Schwartz and Tom Phonex, (2001), Learning Perl, 3rd Edition,
3. Arnold , Essentials of MATLAB for Scientists and Engineers, Wiley NY

REFERENCE BOOKS

1. Larry Wall, Tom Christiansen and Jon Orwant, (2000), Programming Perl, 3rd Edition,
2. Bio Perl – O'Reilly & Associates, (1991)
3. Bio Perl from beginning Perl for Bioinformatics – James Tisdall, (2001)

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**BIOLOGICAL THERMODYNAMICS AND METABOLISM BT420**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Prerequisites: Students should have the basic knowledge of engineering mathematics, Physics,chemistry and basics of Biology.

Course objective:

1. Apply the knowledge of laws of thermodynamics to analyze energy flows in a biological system.

2. Explain different thermodynamic properties and describe obtainable work from engineering and biological systems

3. The course introduces the students to the fundamentals of Bioenergetics and Cell Metabolism

4. The course imparts knowledge addressing the concepts dealing with the flow of energy in biological systems, the conversion of macronutrients into biologically usable forms of energy through different metabolic pathways.

5. The course explains the role of enzymes help in modifying, regulating and controlling metabolic pathways

Course outcomes:

After completing the course students will able to

CO-1 Apply knowledge of basic life science, and engineering in solving differential equations and applying chemical concepts to solve biological engineering problems**.**

CO-2 Identify, formulate, and solve engineering problems related to metabolic thermodynamics

CO-3 Explain the thermodynamics of the living system with special focus on electron transport chain and photosynthesis.

CO-4 Describe the synthesis and degradation of the carbohydrates and Amino Acid Metabolism

CO-5 Summarize the role and importance Lipid and Nucleic Acid metabolism in the living system.

UNIT 1. FUNDAMENTAL CONCEPTS IN THERMODYNAMICS

Systems, surrounding and processes, Homogeneous and heterogeneous systems, closed and open systems. State and properties, intensive and extensive properties. State and path functions, Equilibrium state and phase rule. Zeroth law of thermodynamics. Heat reservoirs and heat engines, reversible and irreversible processes. Work, Energy, Heat, Energy Balance for closed system, Mass and energy balance for open system, Enthalpy, entropy, Gibbs free energy and its application: photosynthesis, glycolysis, citric acid cycle, osmosis and dialysis, standard free energy change and equilibrium constants with example of chemical and biological reactions. General statements of first law of thermodynamics, first law of thermodynamics for cyclic, non flow and flow processes. Heat capacity. Second law of thermodynamics, Concept of entropy. The Carnot principle, Clausius inequality, calculations of entropy changes, entropy and irreversibility. Third law of thermodynamics

12 Hours

UNIT 2. THERMODYNAMIC PROPERTIES OF PURE FLUIDS AND METABOLIC THERMODYNAMICS

.Classification of thermodynamic properties, work functions, Gibbs free energy. Relationships among thermodynamic properties: exact differential equations, fundamental property relations,

Maxwell's equations, Clapeyron equations. Entropy-heat capacity relationships, differential equations for entropy, modified, equation for internal energy and enthalpy (H), effect of temperature on U, H and Entropy (S), relationship between C_P and C_V. Gibbs Helmotz equation, Energetic of metabolic pathways, energy coupling (ATP and NADH);

10 Hours

UNIT 3: INTRODUCTION TO BIOENERGETICS

Stages of energy transformation in living systems, living organisms and thermodynamics, concept of free energy- free energy and living organisms, standard Free Energy, relationship between Standard Free Energy Change and Equilibrium Constant. Exothermic and endothermic reactions, high energy compounds, ATP- universal currency of free energy in biological systems, Energy coupling, Biological oxidation, redox reactions. Calculations of energy yields, electron transport chain, Oxidative phosphorylation- salient features and energetics. Photosynthesis – photo systems. Light reactions and Dark reactions.

10 Hours

UNIT 4: METABOLISM OF CARBOHYDRATES AND AMINO ACIDS

Pathway, energetic and regulation of – Glycolsis, Citric Acid Cycle, Gluconeogenesis, pentose Phosphate Pathway, Calvin cycle, glycogen synthesis. Biodegradation of amino acids, deamination, transamination and urea cycle.

10 Hours

UNIT 5: METABOLISM OF LIPIDS AND NUCLEIC ACIDS

Biodegradation and biosynthesis of fatty acids- pathway and energetics, Biosynthesis of cholesterol and phospholipids. Disorders of lipid metabolism. Nucleic acid biosynthesis and degradation pathways and their regulation.

10Hours

TEXT BOOKS:

1. Smith, J.M., Vanness H.C. and Abbot, M.M., Introduction to Chemical Engineering Thermodynamics, 6th Edition, McGraw Hill. 2008

2. Alberty, Robert, A. (2006). Biochemical Thermodynamics: Applications of Mathematica (Methods of Biochemical Analysis), Wiley-Interscience

3. Voet&Voet, (2008), Fundamentals of Biochemistry: Life at the Molecular Level John Wiley New & Sons.

REFERENCE BOOKS:

1. A Textbook Of Chemical Engineering Thermodynamics by K. V. Narayanan, Prentice Hall Of India, New Delhi, 2011.
2. Thermodynamics: From Concepts To Applications by A. Shavit And C. Gutfinger, Taylor & Francis Group, 2009
3. Lars Garby and Poul S Larsen, (2016), Bioenergetics and its thermodynamics foundations, Cambridge University Press

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**BIOPROCESS ENGINEERING AND STOICHIOMETRY BT430**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Prerequisites: Students should have the basic knowledge of engineering Mathematics,Biological thermodynamics, Chemistry and Bioenergetics and metabolism.

Course objectives:

The objectives of the course are to develop concepts and mathematical tools required to understand and analyze

1. Processes involved in Biological systems.
2. Unit operations in product recovery
3. Unit processes in product recovery
4. Models related to Fermentation
5. Energy balances in different processes

Course outcomes:

After completing the course students will be able to

CO-1 Apply basic engineering principles to systems containing biological systems to meet the needs of the society.

CO-2 Analyze and solve problems related to separation techniques used in bioprocess industry.

CO-3 Analyze and solve problems related material balance in different unit processes and design reactors for chemical and biochemical processes.

CO-4 Interpret the kinetics of living cells and to develop a model to calculate the yields during fermentation processes by applying suitable numerical techniques.

CO-5 Identify, formulate, and solve engineering problems related to metabolic thermodynamics by applying energy balance.

UNIT1: INTRODUCTION TO BASIC CHEMICAL CONCEPTS

Units, dimensions and conversion of units. Phase rule, law of mass, concept of mole and molecule, normality, molality, percentage by weight, mole and volume. Continuity equation, energy equation, Henry's law, Rault's law. General material balance equations.

08 Hours

UNIT2: MATERIAL BALANCE WITHOUT CHEMICAL REACTION

Material balance in distillation, absorption, extraction, crystallization, drying, mixing and evaporation operations. Material balance involving bypass recycle and purging.

12 Hours

UNIT3: MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS

Principles of stoichiometry. Definitions of limiting and excess reactants, fraction and percentage conversion, yield and percentage yield. Selectivity and related problems. Fuels and combustion, calculations involving excess air and air fuel ratio.

12 Hours

UNIT4: METABOLIC STOICHIOMETRY AND ENERGETICS STOICHIOMETRY AND DIGITAL COMPUTATION

Stoichiometry of cell growth and product formation. Elemental balances, degrees of reduction of substrate and biomass. Yield coefficients of biomass and product formation. Energetic analysis of microbial growth and product formation. , Numerical techniques, Application of software.

10 Hours

UNIT5: ENERGY BALANCE

General energy balance equations. Heat capacity. Estimation of heat capacity for solids, liquids gases and their mixtures. Standard heat of formation, standard heat of reaction, standard heat of combustion, Calorific value. Biochemical equilibrium constant and conversion.

10 Hours

TEXT BOOKS:

1.Bhatt,B and Vora, S.M. (2004) Stoichiometry, IV Ed. Tata McGraw Hill Pub.

REFERENCE BOOKS:

1. Stanbury, P.F..Whitkar, A. & Hall, S.J. (2007) Principles of Fermentation Technology, Aditya Book (P) Ltd., New Delhi

2.Shuler, M.L.andKargi, F.(2005) Bioprocess Engineering, Prentic Hall India,

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**ENZYME TECHNOLOGY BT440**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Prerequisites: Students should have the basic knowledge of Chemistry Biochemistry, Cell Biology, Cellular metabolism and Microbiology

Course objective:

The objective of the course is to

1. The course introduces the students to the fundamentals of Enzymology.
2. The course imparts knowledge on chemistry of enzyme and its action, enzymes as biocatalysts
3. The course emphasizes on the functions of enzymes.
4. The course explains the importance of isoenzymes in clinical diagnosis of various disorders.
5. The course correlates the enzymes and their biotechnological applications

Course outcomes:

After completion of the course students will be able to

CO-1 Explain the basic principles of Enzymology

CO-2 Define and classify the enzymes and understand their kinetic principles.

CO-3 Relate the structure and functions of enzymes.

CO-4 Summarize the role enzymes and an intricate understanding on the biocatalysts, catalytic mechanism, medical applications, biological, clinical and industrial uses.

CO-5 Distinguish the enzyme technological processes in biotechnology and procedures for the lay-out of enzyme technological processes like biotransformation and enzyme immobilization

UNIT 1: INTRODUCTION TO ENZYMES AND BIOCATALYSTS

Introduction to enzymes, nomeclature and IUB classification of enzymes with examples, sources,localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes.Units of enzyme activity, and specific activity. Effect of substrate concenteration, temperature and pH on enzyme catalyzed reaction.

Advantages of enzymes *vs* chemical catalysts. Isolated enzymes v/s whole cell systems, enzymes in fermentation. **10 Hours**

UNIT 2 : MECHANISM OF ENZYME CATALYSIS AND ENZYMES KINETICS

Mechanisms of enzyme Catalysis**:** Transition state theory, solvation and desolvation theories, substrate strain theory, acid base catalysis, covalent catalysis, metal ion catalysis. Mechanism of action of coenzymes (NAD/$NADH^+$ and NADP/NADPH, FAD/FADH2). Rate of a reaction, MichaelisMenten equation, initial velocity approach, steady state approach. Vmax., Km, and their significance. Linear transformation of MichaelisMenten equation -Lineweaver Burk plot. Enzyme Inhibition - Competitive, non competitive, uncompetitive and product inhibition. Irreversible inhibition - suicide inhibition.

10 Hours

UNIT 3: ENZYMES AND ISOENZYMES: BIOLOGICAL AND MEDICAL IMPORTANCE

Acetylcholinesterase and their inhibitors, pseudocholinesterase, angiotensin converting enzyme (ACE) and their inhibitors, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD, immunoreactive trypsinogen (IRT). Normal levels of clinically important serum isoenzymes and their significance. Assay of these enzymes. Explanation about SGPT, SGOT, LDH, CK, alkaline phosphatase and acid phosphatases during diseases.

10 Hours

UNIT 4: INDUSTRIAL USES OF ENZYMES

Enzymes used in detergents, use of proteases in food, leather and wool industries. Uses of lactase in dairy industry, glucose oxidase and catalase in food industry; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes), Pectinases.

10 Hours

UNIT 5: ENZYME BIOTRANSFORMATION AND IMMOBILIZATION OF ENZYMES

Enzyme catalyzed biotransformations. Biocatalysts from extreme thermophilic and hyperthermophilic microorganisms (extremozymes). Biotransformation of drugs (hydroxylation of Steroids). Introduction to immobilization of enzymes, techniques of enzyme immobilization. Applications of immobilized enzymes in bioconversion processes. Economics of immobilization

12 Hours

TEXT BOOKS

1.Trevor Palmer, (2006), Enzymes – Biochemistry, Biotechnology, Clinical Chemistry, Horwood publishing.

2. Faber, (2005), Biotransformations in organic synthesis, Springer.

3. M.F. Chaplin and C. Bucke, (2009), Enzyme Technology , Cambridge University Press

REFERENCE BOOKS

1. Dixon and Webb, (2007), Enzymes, IRL Press.

2. W. Gerhartz, (2010), Enzymes in Industry – Production and Applications, VCH Publishers, NY.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**HEAT AND MASS TRANSFER OPERATIONS BT450**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Prerequisites: Students should have the basic knowledge of engineering mathematics, Physics,Chemistry and Biological Thermodynamics.

Course objectives:

The objective of the course is to understand

1. The principles of Conductive and convective heat transfer.
2. Working principle of evaporators and economics related to the process.
3. Different types of Heat exchangers and their design
4. Principles of mass transfer
5. Simultaneous heat & mass transfer operations, and apply them in Biotechnological processes.

Course outcomes:

After completion of the course students will be able to

CO-1 Blend the principles and mechanism of heat transfer in biochemical operations.

CO-2 Will be able to differentiate with types of evaporators and analyze the economy associated with it. Also the heat transfer mechanism with respect to radiation.

CO-3 Select the suitable heat exchanger for thermal processing of biological materials.

CO-4 Blend the principles of mass transfer operations with respect to binary mixtures and analysis of distillation columns

CO-5 Adopt the suitable mass transfer techniques for bioprocessing and downstream processing.

UNIT 1: CONDUCTIVE AND CONVECTIVE HEAT TRANSFER

Modes of heat transfer. Conduction - Fourier's law, steady sate heat conduction through plane wall. Heat flow through composite plane walls, hollow cylinders and spheres. Insulation -types, critical thickness of insulation. Extended surface fins. Classification of convection, forced and natural convection. Individual and overall heat transfer coefficients, log mean temperature difference. Flow arrangement in heat exchangers. Condensation - film wise and drop wise condensation. Different types of condensers

12 Hours

UNIT 2: RADIATION AND EVAPORATION

Introduction to radiation, absorptive, reflectivity, transitivity. Black body radiations, Kirchhoff's law. Emissive power and emissivity, gray body. Steafan - Boltzmann law, Planck's law, Wien's displacement law. Construction and design of evaporators: capacity, steam economy, methods of increasing economy, single and multiple effect evaporators, forward feed, back ward feed and mixed feed methods. Boiling point elevation.

9 Hours

UNIT 3: HEAT EXCHANGERS AND BASICS OF MASS TRANSFER MASS TRANSFER OPERATIONS

Construction and design of double pipe, shell and tube, plate, and scrapped surface heat exchangers. Mass transfer operations. Diffusion – types, Flick's law of diffusion, measurements of diffusivity. Mass transfer co-efficient. Dimensionless numbers.

11Hours

UNIT: 4 MASS TRANSFER OPERATIONS - 1

Distillation: Types of distillation, simple distillation, steam distillation, azeotropic distillation, distillation of binary mixtures, Raoult's law. Distillation columns, McCabe Thiele method

9 Hours

UNIT: 5 MASS TRANSFER OPERATIONS - 2

Extraction: Types of extraction (liquid-liquid and solid-liquid), super critical fluid extraction, properties of super critical fluids, example for super critical fluids. Absorption. Adsorption – types of adsorption, Drying, Crystallization.

11 Hours

TEXT BOOKS:

1.McCabe, W.L. & Smith, J .C. and Harriot, H.P. Unit Operations in Chemical Engineering, McGraw-Hill. 4th edition 2009

2.Treybal, Robert E. Mass Transfer Operations, McGraw-Hill Publications, New York, 1st Edition. 2008

REFERENE BOOKS

1. Coulson,J.M. and Richardson, J.F. Chemical Engineering**,** McGraw-Hill Publications Vols I &II. 2006

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**MOLECULAR BILOGY BT460**
No. of Teaching Hours – 52	**Credits : 4:0:0 L-T-P**
CIE Marks : 50	**SEE Marks : 100**

Pre-requisite:

Student should have the basic knowledge of Biology, Cell Biology, Genetics, Biochemistry and Microbiology

Course Objectives:

1. The course introduces the students to the fundamentals of Molecular Biology, Biological information storage, transmission and expression.
2. The course provides opportunity to understand the principle and mechanism of Replication in Prokaryotes and Eukaryotes.
3. The course highlights the differences in Prokaryotes and Eukaryotes in Protein synthesis
4. The course provides opportunity to understand the biological significance of gene expression, regulation and modification
5. The course explains the impact of alteration of DNA on living organisms.

Course Outcomes:

After completion of the course students will be able to

CO-1 Define and develop an understanding underlying the basic principles of Molecular Biology

CO-2 Describe and differentiate the mechanism of DNA replication in prokaryotes and Eukaryotes

CO-3 Understand and differentiate the detailed protein synthesis in Prokaryotic and Eukaryotic system

CO-4 Evaluate the mechanism and causes of gene modification, regulation and their consequences

CO-5 Explain the impact of DNA damage, mutation and modification and analyze about its advantage and disadvantage to living organisms.

UNIT 1: INTRODUCTION

Organisation of Prokaryotic and Eukaryotic chromosome, DNA as genetic material, Information flow in biological systems: central dogma . Structures and forms of nucleic acids – DNA and RNA.

10 Hours

UNIT 2: REPLICATION

Replication of DNA, Enzymes of DNA replication, structure and function of DNA polymerases, models of replications in prokaryotes and eukaryotes, mechanism of DNA replication.

10 Hours

UNIT 3: TRANSCRIPTION & TRANSLATION

Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), eukaryotic RNA polymerases, mechanism of transcription in prokaryotes and eukaryotes, transcription factors, posttranscriptional processing, transcription inhibitors

Genetic Code, Mechanism of translation, Post translational modification. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation

12 Hours

UNIT 4: GENE EXPRESSION IN PROKARYOTES & EUKARYOTES

Structure and Classification of genes, Regulation of gene expression in prokaryotes: Operon model, gal, lac, trp Operons; positive versus negative regulation.

Regulation of eukaryotic gene expression, transcriptional control, monitoring gene expressions

10 Hours

UNIT 5: MUTATION

Mutation, Molecular forms of mutation. Transposable elements in prokaryotes and eukaryotes. DNA damage and repair, Mutational disorders.

10 Hours

TEXT BOOKS:

1. David Freifelder, 1993**,Essentials of Molecular Biology** , Jones and Bartlett Publishers.

2 Alberts, Lewis, Raff, Roberts and Walter.1994. **Molecular Biology of the Cell.** Garland Publishing.

REFERENCE BOOKS:

1. Brown.T.A. 2006. **Genomes**. Garland Science Publishers.

2. HarveyLodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore and James Darnell, 1991, Molecular Cell Biology, W.H.Freeman and Company Publishers.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**ENZYME TECHNOLOGY LAB BT47L**
No. of Teaching Hours – 39	**Credits : 0:0:2 L-T-P**
CIE Marks : 50	**SEE Marks : 50**

Prerequisites: Students should have the basic knowledge of Biology, Biochemistry andfundamentals of Enzyme Technology

Course objective:

This lab course imparts practical training in the basics of enzyme technology and to understand a biocatalytic process and design bioreactors for large scale applications.

Course outcomes:

After completing the course students will able to

CO-1 Determine an experimental objective and design experiments regarding enzyme characterization parameter

CO-2 Validate experimental results with standard values and establish quantitative and qualitative relationship.

List of experiments:

1.Isolation of enzymes from microbial/ plant source

2. Determination of enzyme activity

3. Effect of substrate concentration on enzyme activity (Km & Vmax determination),

4. Effect of pH on enzyme activity

5. Effect of temperature on enzyme activity

6. Effect of inhibitors on enzyme activity (determination and calculation of KI)

7. Determination of energy of activation

8. Molecular weight determination of enzymes

9. Ammonium sulphate fractionation and desalting

10. Gel filtration chromatography

11. Enzyme Immobilization

12. Estimation of Alkaline Phosphatase, Acid Phosphatase.

13. Estimation of SGOT, SGPT.

14. Estimation of LDH.

TEXT BOOKS

1. Bailey, J.E. and Ollis, D.F. (1986) Biochemical Engineering Fundamentals, Mcgraw Hill.

2. Gerhartz, W. (1990) Production and Applications – Enzymes in Industry, VCH Publishers, New York.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**MOLECULAR BIOLOGY LABORATORY** **BT48L**
No. of Teaching Hours – 39	**Credits : 0:0:2 L-T-P**
CIE Marks : 50	**SEE Marks : 50**

Prerequisites: Students should have the basic knowledge of Biology, Microbiology and fundamentals of Molecular Biology

Course objective:

1. The course aims at understanding basics of Molecular Biology
2. The course aims at giving practical exposure in conducting, designing and planning experiment in Molecular techniques.

Course outcomes:

After completing the course students will able to

CO-1 Determine an experimental objective and design experiments regarding advance molecular techniques.

CO-2 Analyze experimental data using standard methods to establish quantitative and qualitative results

List of experiments:

1. DNA extraction from microorganisms using Phenol-Chloroform technique.
2. DNA quantification using spectrophotometric techniques.
3. Submerged gel Electrophoresis of DNA and gel docking.
4. Restriction enzyme digestion
5. Ligation experiments.
6. Plasmid DNA Extraction from E.coli using alkaline lysis method
7. Designing of RNA primers using software tools

8. Polymerase chain reaction: Programming and standardization

9. Southern blotting technique.

10. Northern Blotting technique.

11. DNA sequencing technique.

12. DNA mutation studies on Bacteria.

13. Real time PCR : Programming and standardization

14. Bacterial cloning experiments

TEXT BOOKS:

1. David Freifelder, 1993**, Essentials of Molecular Biology** , Jones and Bartlett Publishers.

2 Alberts, Lewis, Raff, Roberts and Walter.1994. **Molecular Biology of the Cell.** Garland Publishing.

Department of Biotechnology, SJCE, Mysuru

Subject Name & Code	**UNIT OPERATIONS LABORATORY BT49L**
No. of Teaching Hours – 39	**Credits : 0:0:2 L-T-P**
CIE Marks : 50	**SEE Marks : 50**

Prerequisites: Students should have the basic knowledge of engineering Mathematics, Physics, Chemistry, Momentum and mechanical operations and Heat and mass transfer operations

COURSE OBJECTIVE:

1. The course aims at understanding basics of unit operations involved in Bioprocessing
2. The course aims at giving practical exposure in designing, planning, conducting engineering experiments and writing report

COURSE OUTCOMES:

After completing the course students will able to

CO-1 Determine an experimental objective and operate the relevant equipment related to separation and flow measurement safely.

CO-2 Analyze experimental data using standard methods to establish quantitative and qualitative results

LIST OF EXPERIMENTS:

1. Determination of average particle size by screening
2. Flow rate measurements using orifice meter / venturimeter
3. Flow rate measurements using rotameter
4. Determination of Thickener area by batch sedimentation test
5. Study of pump characteristics (single stage and multi stage centrifugal pump)

6. Determination of time of filtration at Constant pressure/constant rate filtration using leaf filter

7. Separation of liquid –liquid mixture using Simple distillation

8. Separation of liquid –liquid mixture using Steam distillation

9. Extraction of liquid in liquid mixture using suitable solvent

10. Determination of drying characteristics using tray dryer

11. Calculation of heat transfer rates in packed beds

12. Calculation of Heat transfer co-efficient in shell and tube heat exchanger

13. Calculation of Heat transfer in co-efficient double pipe heat exchanger

14. Diffusivity measurements

15. Determination of type of flow in different sizes of pipes

TEXT BOOKS:

1. Coulson, J M and Richardson, J.F. Chemical engineering**,** McGraw-Hill Publications Vols I &II
2. McCabe, W.L. & Smith J.C, Unit operations in Chemical Engineering, McGraw-Hill
3. Kumar, K.L. Fluid Mechanics, S. Chand and Company Ltd

REFERENCE BOOKS:

1. Treybal, R.E. Mass Transfer Operations , McGraw-Hill Publications, New York, 1st Edition
2. Kern, J**.** Process Heat Transfer, McGraw-Hill Publications