SunRise University

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SYLLABUS OF BACHELOR IN BIOCHEMISTRY (HONOURS)

FIRST SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHBC101	English	40	60	100
BSHBC102	Environmental Science	40	60	100
BSHBC103	Basic Biochemistry	40	60	100
BSHBC104	Cell Biology	40	60	100
BSHBC105	Physical Aspects of Biochemistry	40	60	100
BSHBC106	General and Organic Chemistry	40	60	100
BSHBC107	Medical &Microbial Techniques	40	60	100
PRACTICAL				
BSHBC108	Basic Biochemistry Practical	60	40	100
BSHBC109	Cell Biology Practical	60	40	100
BSHBC110	Physical Aspectsof Biochemistry Practical	60	40	100
BSHBC111	General and Organic chemistry Practical	60	40	100
Total		**520**	**580**	**1100**

SECOND SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHBC201	Enzymology	40	60	100
BSHBC202	Metabolism I	40	60	100
BSHBC203	Microbiology	40	60	100
BSHBC204	Biochemistry Laboratory	40	60	100
BSHBC205	Biochemical Techniques	40	60	100
BSHBC206	Principles of Drug Discovery	40	60	100
BSHBC207	Bioinformatics	40	60	100
PRACTICAL				
BSHBC208	Enzymology Practical	60	40	100
BSHBC209	Metabolism I Practical	60	40	100
BSHBC210	Microbiology Practical	60	40	100
BSHBC211	BiochemistryLaboratory Practical	60	40	100
Total		**520**	**580**	**1100**

THIRD SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHBC301	Human Physiology	40	60	100
BSHBC302	Metabolism II	40	60	100
BSHBC303	Diagnostic Biochemistry	40	60	100
BSHBC304	Intermediary Metabolism	40	60	100
BSHBC305	Recombinant DNA Technology	40	60	100
BSHBC306	Herbal Technology	40	60	100
PRACTICAL				
BSHBC307	Human Physiology practical	60	40	100
BSHBC308	Metabolism II Practical	60	40	100
BSHBC309	Diagnostic Biochemistry Practical	60	40	100
BSHBC310	Intermediary Metabolism Practical	60	40	100
BSHBC311	Recombinant DNA Technology Practical	60	40	100
Total		**500**	**500**	**1000**

FOURTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHBC401	Molecular Biology	40	60	100
BSHBC402	Basic Concepts in Genetics	40	60	100
BSHBC403	Biochemical Correlation in Diseases	40	60	100
BSHBC404	Protein and Enzymes	40	60	100
BSHBC405	Immunology	40	60	100
PRACTICL				
BSHBC406	Molecular Biology Practical	60	40	100
BSHBC407	Basic Concepts in Genetics Practical	60	40	100
BSHBC418	Biochemical Correlation in Diseases Practical	60	40	100
BSHBC409	Protein and Enzymes Practical	60	40	100
BSHBC410	Immunology Practical	60	40	100
Total		**500**	**500**	**1000**

FIFTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHBC501	Genetic Engineering & Biotechnology	40	60	100
BSHBC502	Hormone Biochemistry	40	60	100
BSHBC503	Plant Biochemistry	40	60	100
BSHBC504	Molecular Basis of Infectious Diseases	40	60	100
BSHBC505	Scientific Methodology & Technical Writing	40	60	100
BSHBC506	Biochemical Application in Forensics	40	60	100
PRACTICAL				
BSHBC507	Genetic Engineering & Biotechnology Practical	60	40	100
BSHBC508	Hormone Biochemistry Practical	60	40	100
BSHBC509	Plant Biochemistry Practical	60	40	100
BSHBC510	Molecular Basis of Infectious Practical	60	40	100
Total		**500**	**500**	**1000**

SIXTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHBC601	Food Biochemistry	40	60	100
BSHBC602	Cancer Biology	40	60	100
BSHBC603	Biophysics	40	60	100
BSHBC604	Biostatistics	40	60	100
BSHBC605	Biosafety and Intellectual Property Rights	40	60	100
PRACTICAL	Food Biochemistry Practical			
BSHBC606	Cancer Biology Practical	60	40	100
BSHBC607	Biophysics Practical	60	40	100
BSHBC608	Biostatistics Practical	60	40	100
BSHBC609	Biosafety and Intellectual Property Rights Practical	60	40	100
BSHBC610	Research Project	60	40	100
Total		**500**	**500**	**1000**

C-1: Basic Biochemistry

SEMESTER –I

THEORY	Subject Code: BSBCT101CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective:

This module is a general introduction to the basic concepts of biochemistry and the functions of carbohydrates, protein, lipids. The module also gives insight to importance of biomolecules.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 –Describe the chemical and molecular foundations of life and the role of energy rich compound in biological systems.

CO.2 – Define the structure, properties and roles of carbohydrates.

CO.3 – Explain the structure, properties and roles of lipids in biological system.

CO.4– Discuss structure, function and acid base properties of amino acids.

CO.5 – Classify the nature, structure and importance of enzymes in living systems.

Unit	Topic/Sub-Topic	Contact Hours
1	Bioenergetic:First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant, Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP	8
2	Carbohydrates: Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses, Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose. Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin	14
3	Lipids: Definition and major classes of storage and structural lipids, Storage lipids. Fatty acids structure andStorage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification, Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine. Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides, Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers	14
4	Proteins: Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acid: Gramicidin,beta- alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring and glutathione and insulin and synthetic aspartame	14
5	Enzymes: Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts	10

C1: Basic Biochemistry (PRACTICAL)

SEMESTER –I

PRACTICAL	Subject Code: BSBCP101CO
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits : 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the basic lab requirements and their uses.

CO.2 – Examine various instruments using in separation and isolation of various analytical compounds.

CO.3 – Analyze the characteristics of the compound on the basis of their pH.

CO.4 – Analyze the characteristics of the compound on the basis of their pH.

CO.5 – Analyze the characteristics of the compound on the basis of their pH.

CO.6– Examine different components present in the extract of radish leaves by using chromatography technique.

CO.7 – Analysis independently of various biomolecules in the laboratory.

S.No.	List of Experiments	Contact Hours
1	Basic Lab requirements Volumetric flask, falcons, mortar and pestle, watch glass, wash bottle, beaker, measuring cylinder, dropper, burette, spatula, reagent bottle, test tube stand, pipette stand, tripod stand, Bunsen burner, wire gauze, crucible, funnel, centrifuge tubes	6
2	Instruments Separatory funnel, centrifuge, pH meter, Electric balance, hot plate	6
3	Determination of pH of various solutions using a pH meter – NaOH, sulphuric acid, distilled water	3
4	Preparation of Normal solution- NaOH	3
5	Preparation of percentage/ vov-vol solutions- Sulphuric acid	3
6	Paper Chromatography- Isolation of the pigments from leaves of Raddish	3
7	Qualitative analysis of Carbohydrate, protein & fats	6

Recommended Books:

- Biometerials: Bhat, Sujata, V., Narosa Publishing House, 2010.
- Principles of Physical Biochemistry: Vanholde & Johnson, P. Shing, Pearson Prentice Hall Upper Saddle River, New Jersey, 2nd Ed. 2005.
- Physical Biochemistry: Principles and Applications: David Sheehan, Wiley, 2nd Ed. 2009.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David, M. Freifelder, ACS publication, 1983.
- Laboratory Manual for Practical Biochemistry: Ganesh M. K. & Shivashankara, A. R., Jaypee publications, 2nd Ed. 2012.

C-2: Cell Biology
SEMESTER –I

THEORY	Subject Code: BSBCT102CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credit: 4

Course Objective: This module is a general introduction to cell biology, its importance in pathology body functioning.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 –Describe the chemical and molecular foundations of cell and the role in biological systems.
CO.2 – Define the structure, properties and roles of nucleus.
CO.3 – Explain the protein sorting and its transport in biological system.
CO.4 – Discuss cell signalling mechanism through various pathways.
CO.5 – Classify the cell cycle, its regulation and development.

Unit	Topic/ Sub Topic	Contact hours
1	Structure of Cell: Plasma membrane: Structure and transport of small molecules , Cell Wall: Eukaryotic cell wall, Fluid mosaic model and details,Extra cellular matrix and cell matrix interactions Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects), Ribosomes, chloroplasts and peroxisomes , Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubule	15
2	Nucleus :Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin–Molecular organization Nucleolus	7
3	Protein sorting & transport: Endoplasmic Reticulum Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Organization, protein glycosylation, and Apparatus protein sorting and export for Golgi apparatus Lysosomes	12
4	Cell Signalling :Signalling molecules and their receptors, Function of cell surface receptors, Pathways of intra-cellular receptors – Cyclic AMP pathway, Cyclic GMP and MAP kinase pathway	14
5	Cell Cycle, Cell Death and Cell Renewal: Eukaryotic cell cycle and its regulation, Development of cancer, causes and types, Programmed cell death, Stem cells, Embryonic stem cells induced pluripotent stem cells	12

C 2: Cell Biology (PRACTICAL)
SEMESTER –I

PRACTICAL	Subject Code: BSBCP102CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe the basic lab requirements and their uses.
CO.2 – Examine various cell organelles through micrograph techniques.
CO.3 – Analyse various nucleic acids through staining techniques.
CO.4 – Examine plolyploidy through onion root with various treatments.
CO.5 – Examine cancer cell by photomicrography.
CO.6 – Analyse various stages of mitosis.
CO.7 – Examine various stages of meiosis cell division.

S.No	List of Experiments	Contact hours
1.	Study a representative plant and animal cell by microscopy	3
2.	Study of the structure of cell organelles through electron micrographs	6
3	Cytochemical staining of DNA – Feulgen	6
4	Study of polyploidy in Onion root tip by colchicine treatment.	3
5	Identification and study of cancer cells by photomicrographs.	6
6	Study of different stages of Mitosis	3
7	Study of different stages of Meiosis	3

Recommended Books:

- The Cell: A Molecular Approach: Geoffrey. M. Cooper and Robert. E. Hausman, Sinauer Associates, 5th Ed. 2009.
- Molecular Cell Biology: W. H. Freeman Lodish, 5th Ed. 2003.
- Molecular Biology of the cell: Bruce Alberts, Garland Publishing, 5th Ed. 2008.
- Laboratory Manual for Practical Biochemistry: Ganesh M. K. & Shivashankara A. R., Jaypee Publications, 2nd Ed. 2012.

C-3: Enzymology
SEMESTER –II

THEORY	Subject Code: BSBCT203CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of Enzymes and their functions. The module also gives insight to importance of Enzymes.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe the classification and nomenclature of enzymes, specificity of enzyme action, enzyme catalysis and regulatory enzymes.
CO.2 – Explain the mechanism of enzymes and the role of vitamins as coenzyme precursors.
CO.3 – Express the Michaelis-Menten equation, single and double reciprocal plots, and graphical representation of various inhibitors.
CO.4 – Discuss the factors affecting enzyme activity and enzyme isolation & purification.
CO.5 – Describe the principles and methods of enzyme immobilization.

Unit	Topic/ Sub Topic	Contact Hours
1	History & Terminology:Classification& nomenclature of enzymes, Specificity of enzyme action (Lock & key model & Induced fit model)., Enzyme catalysis: Proximity & Orientation effect, covalent catalysis, acid-base catalysis, metal ion catalysis. Regulatory enzymes: - Allosteric (ATCase) & covalently modulated (Glycogen phosphorylase) enzymes.	12
2	Mechanism of Enzymes: Mechanism of action of Chymotrypsin and Ribonuclease. Role of vitamins as coenzyme precursors (Riboflavin, Niacin, Pyridoxine, Biotin and Thiamine), Effect of enzyme concentration, upward & downward curvatures with examples., Effect of temperature on enzyme activity & temperature quotient.	12
3	Enzyme kinetics:Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Graphical representation of various inhibitors (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots. Importance of Kcat / Km. Bisubstrate reactions – brief introduction to sequential and ping-pong mechanisms with examples.	12
4	Factors Effecting enzyme activity: General pH profile diagram with exceptions, Concept of enzyme assay & its importance, Enzyme activity units (Katal & Specific activity), Enzyme isolation and purification:- Enzyme solubilization, Brief idea of various fractionation procedures, Criteria for enzyme purity and homogeneity,	12
5	Immobilization of Enzymes Principle and methods of enzyme immobilization Multi-enzyme system Industrial processes, utilization and regeneration of co-factors	12

C3: Enzymology (PRACTICAL)

SEMESTER –II

PRACTICAL	Subject Code: BSBCP203CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1- Explain purification of proteins by various methods.

CO.2- Estimate enzyme activity by different methods.

CO.3- Explain progress curve of enzyme.

CO.4- Interpret the effect of physical parameters on enzyme activity.

CO.5- Practice the effect of physical parameters on enzyme activity.

CO.6- Practice the effect of inhibitors on enzyme activity.

CO.7- Demonstrate the continuous assay of an enzyme.

S.No.	List of Experiments	Contact hours
1	Partial purification of an enzyme using bulk methods or chromatography	6
2	Assay to determine enzyme activity and specific activity	6
3	Progress curve plot for an enzyme	3
4	Effect of pH/temperature on enzyme activity	3
5	Determination of K M and V max using Lineweaver-Burk plot	6
6	Calculation of inhibitory constant (Ki) for an enzyme	3
7	Continuous assay of an enzyme	3

Recommended Books:

- Lehninger Principles of Biochemistry: D. L. Nelson, Michael M. Cox, International Edition, CBS publishers, 4th Ed. 2004.
- Biochemistry: Stryer: W. H. Freeman & Co., Scintific Research an Academic Publisher, New York. 4th Ed. 1995.
- The Nature of Enzymology: Foster – Croom Helm, London. Wiley, 1980.
- Fundamentals of Enzymology: Price & Stevens – Oxford Science Publication. 2nd Ed. 1989.

C-4: Metabolism I
SEMESTER –II

THEORY	Subject Code: BSBCT204CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credit- 4

Course Objective: This module is a general introduction to the metabolism of biomolecules (Carbohydrates, Lipids and the basic energetics).

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Describe the fundamentals of thermodynamics in biochemical processes.
CO.2 – Acquire the knowledge of energy production in living systems by the degradation of fatty acids.
CO.3 – Explain the various pathways of fatty acid synthesis in living systems.
CO.4 – Describe the energy generated from the carbohydrate metabolism.
CO.5 – Explain the mechanism of the machinery system involved in carbohydrate metabolism.

Unit	Topic/ Sub Topic	Contact hours
1	Bioenergetics: Concept of free energy, Entropy, Enthalpy & Redox Potential. Determination of ΔG0' for a reaction, High energy phosphate compounds (Ex. ATP, Phosphoenol pyruvate, Creatine phosphate etc) – phosphate potential, Free energy of hydrolysis of ATP along with reasons for high ΔG0,. Other high energy compounds, ATP-ADP Cycle, Energy charge (Phosphate potential) & its relation to metabolic regulation.	10
2	Lipid metabolism: Hydrolysis of triacylglycerols, transport of fatty acids into mitochondria (Carnitine), Detailed account of - oxidation of fatty acids (-oxidation in mitochondria and peroxisomes), Oxidation of unsaturated fatty acids & odd carbon fatty acids. Oxidation- Brief idea. ATP yield from fatty acid oxidation. Regulation, Detailed account of HMP Shunt & its significance in general, its connection to lipid metabolism.	14
3	Lipid metabolism: Ketogenesis, Ketosis & ketoacidosis in physiology & pathology, Biosynthesis of fatty acids, Fatty acid synthase complex, Regulation, Microsomal & Mitochondrial system of chain elongation & synthesis of unsaturated fatty acids, Biosynthesis of triglycerides & phospholipids (Phosphatidyl-ethanolamine, choline, inositol), sphingolipids.	12
4	Carbohydrate metabolism: Detailed account of glycolysis with energy considerations & regulation, Entry of fructose, mannose & galactose in glycolysis, Cori cycle, Futile or substrate cycles in carbohydrate metabolism, Glycogenolysis & Glycogenesis – Detailed account & hormonal control. Glycogen storage diseases, Formation of acetyl CoA & detailed account of TCA Cycle, Isotopic tests of TCA cycle (Concept of Prochirality), Regulation, Amphibolic and anaplerotic nature of TCA cycle.	12
5	Carbohydrate metabolism: Glyoxylate cycle and its role in conversion of fats into carbohydrates, Gluconeogenesis– Detailed account of bypass reactions, Regulation, Malate & glycerophosphate shuttle system,Electron Transport chain-Structure of mitochondria, oxidative and substrate level phosphorylation, Electron carriers of ETC, Incomplete reduction of oxygen (Cell injury – superoxide radicle), ATP Synthase (F1 F0 ATPase), Chemiosmotic hypothesis, Sites of ATP synthesis, Specific inhibitors and uncouplers of oxidative phosphorylation.	12

C4: Metabolism I (PRACTICAL)
SEMESTER –II

PRACTICAL	Subject Code: BSBCP204CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 Explain biochemical parameter of biological sample.
CO.2- Explain fermentation process by microorganism.
CO.3- Explain enzyme assay of salivary enzyme.
CO.4- Apply the various techniques for isolation of lipids.
CO.5- Practice the biochemical parameters in biological system.
CO.6- Practice the estimation of plasma sugar.
CO.7- Demonstrate the cholesterol level from known sources

S.No.	List of Experiments	Contact hours
1	Estimation of blood glucose.	4
2	Sugar fermentation by microorganisms.	6
3	Assay of salivary amylase.	3
4	Isolation of lipids from egg yolk and separation by TLC.	6
5	Cholesterol estimation.	4
6	Estimation of plasma sugar	3
7	Estimation of cholesterol from known source (Mustard oil)	4

Recommended Books:

- Harper's Biochemistry: Murray, Granner, Mayes, Rodwell , Prentice Hall International Inc. 28th Ed. 2009.
- Lehninger Principles of Biochemistry: D. L. Nelson, Michael M. Cox, International Edition, CBS publishers, 4th Ed. 2004.
- Biochemistry: Stryer: W. H. Freeman & Co., Scintific Research an Academic Publisher, New York. 4th Ed. 1995.
- Biochemistry: Geoffrey L. Zubay, McGraw Hill. 1997.
- Biochemistry: J. David Rawn, Neil Patterson publs. NC. 1989.
- Textbook of Biochemistry: West, Todd, Mason, Bruggen – Amerind Publishing Co. Pvt. Ltd. 4th Ed. 1986.
- Biochemistry: U Satyanarayana, U. Chakrapani, Elsevier, 4th Ed. 2013.
- Biochemistry- U Satyanarayana, U. Chakrapani, Elsevier, 4th edition. (2013).

C-5: Human Physiology
SEMESTER –III

THEORY	Subject Code: BSBCT305CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credit: 4

Course Objective: This module is a general introduction to the organization of body fluid, cardiovascular physiology and neurotransmission. The module aims to understand the mechanisms of living, from the molecular basis of cell function to the integrated behaviour of the whole body.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Describe the homeostasis and organization of fluid compartments of the human body.
CO.2 – Acquire the knowledge of the organization and physiology of the cardiovascular system.
CO.3 – Describe the organization and mechanism of the respiratory stem.
CO.4 – Explain the organization and chemistry of the nervous system.

Unit	Topic/ Sub Topic	Contact hours
1	Homeostasis and the organization of body fluid compartments Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis.	15
2	Cardiovascular physiology, Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automacity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction	17
3	Respiration, Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea,pulmonary distress, emphesema.	14
4	Neurochemistry and neurophysiology: Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory.- Enzyme solubilization, Brief idea of various fractionation procedures, Criteria for enzyme purity and homogeneity,	14

C 5: Human Physiology (PRACTICAL)

SEMESTER –III

PRACTICAL	Subject Code: BSBCP305CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course objective: The students perform and analyze various physiological tests that examine the function of various systems of the human body.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Prepare blood smear for calculation of blood indices.

CO. 2- Demonstrate iron binding capacity with biological components.

CO. 3- Demonstrate pulmonary function test.

CO. 4- Practice clinical test by various case studies.

CO. 5- Employ isolation of various isoezymes of different enzymes by electrophoresis.

S.No.	List of Experiments	Contact hours
1	Hematology : 1. Packed Cell Volume, Bleeding Time and Clotting time. 2. Preparation of blood smear and Differential leucocyte count. 3. Enumeration of Blood cells: RBC and WBC counting, Calculation of blood Indices. 4. Estimation of haemoglobin	6
2	Determination of total iron binding capacity.	6
3	Pulmonary function tests, spirometry and measurement of blood pressure.	6
4	Case studies: Renal clearance, ECG, LFT, EEG (any two)	6
5	Separation of isoenzymes of LDH by electrophoresis.	6

Recommended Books:

- Anatomy & Physiology: Gerard J. Tortora & Bryan Derrickson, Willey Publication, Indian Ed. 2014.
- Textbook of Anatomy & physiology for Nurses and Allied Health Sciences: Indu Khurana, CBS Publishers & Distributors Pvt Ltd. 2015.
- Ross And Wilson Anatomy & Physiology in Health and Illness: Anne Waugh, & Allison Grant, Churchill Livingstone Elsevier, 12th Ed. International Edition 2014.

C6: Metabolism II

SEMESTER –III

THEORY	Subject Code: BSBCT306CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credit: 4

Course Objective: This module is a general introduction to the basic concepts of metabolism of the body and functions of biomolecules. The module also gives insight to importance of biomolecules and vitamins.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the basic concept of nitrogen incorporation in the diet as well as the mechanism by which ammonia is incorporated in biomolecules.

CO.2 – Discuss breakdown and synthesis of amino acids in humans and recognize its relevance with respect to nutrition and human diseases.

CO.3 – Describe how amino acids are converted into a variety of precursors.

CO.4 – Describe breakdown and synthesis of nucleotides in humans and recognize its relevance with respect to nutrition and human diseases.

CO.5 – Explain inhibitors of nucleotide metabolism, which are potentially being used as chemotherapeutic drugs.

Unit	Topic/ Sub Topic	Contact hours
1	Nitrogen Balance: Positive and negative nitrogen balance, protein quality: complete and incomplete proteins, criteria to assess protein quality, protein calorie malnutrition, Kwashiorkor and Marasmus.	3
2	Amino Acids metabolism: Digestion, absorption and uptake of Amino Acids including γ-glutamyl cycle; Transamination, oxidative and nonoxidative deamination, glucose-alanine cycle, urea cycle and inherited defects of urea cycle, Glucogenic and ketogenic amino acids, catabolic pathways for the standard amino acids; Metabolism of one-carbon units, Biosynthesis of non-essential amino acids; biosynthesis of Essential amino acids (Only overview-in plants) and their regulation. Disorders of amino acid metabolism: Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Methylmalonic aciduria, Parkinson's disease, Homocystinuria, and Hartnup's disease	13
3	Precursor function of Amino acids: Biosynthesis of Creatine, Creatine phosphate and creatinine; Creatine- Creatine phosphate energy shuttle; polyamines (putresine, spermine, spermidine,); catecholamines (dopamine, epinephrine, nor-epinephrine); and neurotransmitters such as serotonin, GABA; porphyrin biosynthesis and disorders of porphyrin metabolism.	14
4	Biosynthesis of purine nucleotides: Biosynthesis of IMP; pathways from IMP to AMP and GMP; conversion to triphosphates; regulation of purine nucleotide biosynthesis, salvage pathways; synthesis of coenzymes (NAD+, FMN, FAD, HSCoA)	15
5	Matabolic pathway of pyrimidine nucleotides: Biosynthesis of UMP, conversion of triphosphate and regulation of Biosynthesis of pyrimidine nucleotide synthesis; Deoxy ribonucleotides and synthesis of dTTP; inhibitors of nucleotide metabolism and their use as anti bacterial / anticancer drugs. Degradation of purine and pyrimidine nucleotides. Disorders of nucleotide metabolism: Lesch Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency	15

C6: Metabolism II (PRACTICAL)

SEMESTER –III

PRACTICAL	Subject Code: BSBCP306CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO 1- Demonstrate assay for various clinically important enzymes.

CO 2- Demonstrate serum test for various parameters.

CO 3- Demonstrate test serum for various parameters.

CO 4- Practice clinical test by various proteins in biological samples.

CO 5- Employ assays for various ezymes in different samples.

CO 6- Demonstrate serum urea test for various parameters.

S.No.	List of Experiments	Contact hours
1	Assay of serum transaminases – SGOT and SGPT.	5
2	Estimation of serum uric acid.	5
3	Estimation of serum creatinine.	5
4	Estimation of bilirubin	5
5	Assay of glutamate dehydrogenase	5
6	Estimation of serum urea.	5

Recommended Books:

- Biochemistry with Clinical Concepts and Case Studies: Satyanarayana , U. & Chakrapani, U., Elsevier India PVT LTD. 4th Ed. 2013.
- Biochemistry: Satyanarayana , U. & Chakrapani, U., Elsevier, 4th Ed. 2016.
- Biochemistry: Voet, D. & Voet, J. G., John Wiley and Sons, N.Y. USA. 2009.

C-7: Diagnostic Biochemistry

SEMESTER –III

THEORY	Subject Code: BSBCT307CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is designed to aware the students for diagnosis of disorder in human regarding human based, hemoglobinopathy, metabolic disorder and inborn errors.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the collection of specimen and their processing.

CO.2 – Classify the blood glucose level, diabetes and anemia.

CO.3 – Interpret the different level of bilirubin as well as liver function test.

CO.4 – Interpret the different level of urea, creatinine, insulin as well as renal function test.

CO.5 – Examine gastric contents, FTM stimulation test and gastric function test.

Unit	Topic/ Sub Topic	Contact hours
1	Specimen collection and processing (Blood, urine, feaces), anti-coagulant and preservatives for blood and urine. Transport of specimens.	10

2	Blood sugar level -factors controlling blood sugar level -hypo, hyper glycemia, Diabetes mellitus, types -GTT, Iron absorption and excretion- Anemia classification. Sickle cell anemia and Thalassemia	12
3	Metabolism of Bilirubin-Jaundice -types differential diagnosis and liver function tests Renal functional test -clearance test -Urea, Creatinine, Inulin, PAH test, concentration and dilution test.	18
5	Gastric functional tests -collection of gastric contents, examination of gastric residues, FTM stimulation test, tubeless gastric analysis.	10
6	Inborn errors of metabolism -Alkaptonuria, Phenyl ketonuria, Cystinuria, Galactosemia, Fanconi's syndrome and Albinism, Cholesterol -importance, Lipoproteins -Factor affecting blood cholesterol -Atherosclerosis, Risk factor	10

C7: Diagnostic Biochemistry (PRACTICAL)

SEMESTER –III

PRACTICAL	Subject Code: BSBCP307CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Demonstrate the specific gravity test for urine sample.
CO.2 – Practice various diseases by case study
CO.3 – Interpret anticoagulant activity for various anticoagulants.
CO.4 – Interpret the different level of transaminases, as well as renal function test.
CO.5 – Examine Widal test for various samples.
CO.6 – Examine ELISA test for various samples.
CO.7 – Analyze proteins in urine samples by various tests.
CO.7 – Analyze glucose tolerance test samples by various tests.

S.No,	List of Experiments	Contact hours
1	Determination of Specific Gravity of Urine	2
2	Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.	3
3	Anticoagulants analysis	2
4	Activity of Aspartate transaminase	3
5	Widal test	6
6	ELISA Test	3
7	Tests for Proteins in Urine	5
8	Oral Glucose Tolerance Test	6

Recommended Books:

- Clinical Chemistry Interpretation and techniques: Kaplan A., Jack, Opheim R. K.E., Toivola B. ,Lyon A.W., Williams and Wilkins, USA, 4th Ed. 1995.
- Clinical Chemistry, Metabolic and Clinical Aspects: Marshall W.J. & Bangert S.K. Churchill Livingstone publisher, 1995.
- Textbook of medicine: Krishnedas K.V., Jaypee Brothes Publisher, 6th Ed. 1996.
- Principles of internal medicine: Harrison, T.R., Fauci, Branuwalad & Isselbaeher, McGraw Hills. 12th Ed. 1998.
- Biochemistry with clinical Correlation: Devlin T.M., Wiley Publications, 7th Ed. 2010.
- Clinical chemistry in diagnosis and treatment: Joan F., Zilva A., Pannall P. R., Llyods Luke Medical Books ltd., Lon 4th Ed. 1984.

C-8: Molecular Biology

SEMESTER –IV

THEORY	Subject Code: BSBCT408CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60 Credits: 4

Course Objective: This module deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, and protein synthesis.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Distinguish the process of replication in prokaryotes as well as eukaryotes.
CO.2 – Distinguish the process of transcription in prokaryotes as well as eukaryotes.
CO.3 – Distinguish the process of translation in prokaryotes as well as eukaryotes.
CO.4 – Discuss the process of transcriptional regulation in prokaryotes as well as eukaryotes.
CO.5 – Explain the process of DNA damage and various DNA repair mechanisms.

Unit	Topic/ Sub Topic	Contact hours
1	The Replication of DNA (Prokaryotes and Eukaryotes) Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins	12
2	Mechanism of Transcription: RNA Polymerase and the transcription unit, Transcription in Prokaryotes, Transcription in Eukaryotes RNA Modifications, Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport,	12
3	Translation (Prokaryotes and Eukaryotes) Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.	12
4	Trannscription Regulation in Prokaryotes,Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, regulation of transcription termination. Transcription Regulation in Eukaryotes,Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing	14
5	The Mutability and Repair of DNA Definitions, Mutation, muton, replicon, principles of mutation, Replication Errors, DNA Damage, different types of mutations, deletions, duplications, UV induced mutations, repair mechanisms against mutations and their importance.	10

C-8: Molecular Biology (PRACTICAL)

SEMESTER –IV

PRACTICAL	Subject Code: BSBCP408CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate assay for nucleic acid by various methods.

CO. 2- Demonstrate isolation process of DNA from different samples.

CO. 3- Apply electrophoresis technique for different isolated compounds.

CO. 4- Illustrate PCR techniques.

CO. 5- Illustrate SDS-PAGE techniques by biomolecules.

CO. 6- Demonstrate effect of various mutagens in various samples.

S.No.	List of Experiments	Contact hours
1	Study of semi-conservative replication of DNA through micrographs / schematic Representations	2
2	Isolation of chromosomal DNA	2
3	Agarose gel electrophoresis and visualization	3
4	PCR	6
5	Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).	3
6	Study the effect of chemical (HNO_2) and physical (UV) mutagens on cells	5
7	Nucleic acid leakage analysis	4
8	To hydrolyze DNA and separate nucleotide bases by paper chromatography	5

Recommended Books:

- Gene cloning & DNA analysis: Brown T. A., Blackwell publishing, Oxford, U.K., 6th Ed. 2010.
- Biotechnology: applying the genetic revolution: Clark D. P. & Pazdernik N. J., Elsevier academic press, USA. 2009.
- Principles of gene manipulation and genomics: Primrose S. B. & Twyman R.M., Blackwell Publishing, Oxford, U.K., 7th Ed. 2006.
- Molecular cloning-a laboratory manual: Sambrook J. & Russell D., Cold Spring Harbor Laboratory Press, 3rd Ed. 2001.
- Prescott, Harley & Klein's Microbiology: Wiley J. M., Sherwood L. M. & Woolverton C. J. Mcgraw Hill Higher Education. 7th Ed. 2008.
- Genomes-3: Brown T. A., Garland science publishers. 2007.

C-9: Basic Concepts in Genetics
SEMESTER: IV

THEORY	Subject Code: BSBCT409CO
Total Marks for Evaluation:100	No. of Contact Hours :60, Credits: 4

Course Objective: This module is a general introduction to the genetics and its practical value for human welfare. The module also gives insight to chromosome abnormalities.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Describe the different model organisms of genetics and basic principles of heredity.
CO.2 – Give examples of the law of probability, binomial expansion, formulating and testing genetic hypothesis.
CO.3 – Discuss about the gene interaction, function, relationship and types of different alleles.
CO.4 – Differentiate between Complementation test and limitations of cis-trans test.
CO.5 – Derive the mechanism of genetic exchange and gene mapping in bacteria.

Unit	Topic/ Sub Topic	Contact hours
1	Introduction to model organisms and Mendelism: Model organisms: Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Caenorhabditis elegans, Danio rerio and Arabidopsis thaliana, Basic principles of heredity.	12
2	Applications of Mendel's principles & chromosomal basis of heredity, Laws of probability & binomial expansion, formulating and testing genetic hypothesis,chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.	12
3	Extensions of Mendelism: Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.	14
4	Genetic definition of a gene: Complementation test, limitations of cis-trans test, intragenic complementation, rII locus of phage T 4 and concept of cistron	12
5	Genetics of bacteria and viruses Prin: Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.	10

C-9: Basic Concepts in Genetics (PRACTICAL)
SEMESTER –IV

PRACTICAL	Subject Code: BSBCP409CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO 1- Demonstrate assay for nucleic acid by various methods.
CO 2- Demonstrate isolation process of DNA from different samples.
CO 3-Illustrate polytene chromosomes using temporary mounts of salivary glands of Chiromonas.
CO 4- Prepare pedigree test for various types of data.
CO 5- Illustrate representative quantitative trait.
CO 6- Demonstrate effect of Barr body in various samples.
CO 7- Analyze Chi- square test for different data.

S.No.	List of Experiments	Contact hours
1	Mendelian deviations in dihybrid crosses	3
2	Karyotyping with the help of photographs	3
3	Study of polytene chromosomes using temporary mounts of salivary glands of Chiromonas /Drosophila larvae	3
4	Study of pedigree analysis	6
5	Analysis of a representative quantitative trait	3
6	Studying Barr Body with the temporary mount of human cheek cells	6
7	Chi-Square Analysis	6

Recommended Books:

- Gene cloning & DNA analysis: Brown T. A., Blackwell publishing, Oxford, U.K., 6th Ed. 2010.
- Biotechnology: applying the genetic revolution: Clark D. P. & Pazdernik N. J., Elsevier academic press, USA. 2009.
- Principles of gene manipulation and genomics: Primrose S. B. & Twyman R.M., Blackwell Publishing, Oxford, U.K., 7th Ed. 2006.
- Molecular cloning-a laboratory manual: Sambrook J. & Russell D., Cold Spring Harbor Laboratory Press, 3rd Ed. 2001.
- Prescott, Harley & Klein's Microbiology: Wiley J. M., Sherwood L. M. & Woolverton C. J. Mcgraw Hill Higher Education. 7th Ed. 2008.
- Genomes-3: Brown T. A., Garland science publishers. 2007.

C-10: Proteins

Semester IV

THEORY	Subject Code: BSBCT410CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is elucidating the detailed molecular structure of proteins and their functions. The module also gives insight to importance of proteins.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the hierarchy of protein architecture with the features of conjugated and metallo proteins.

CO.2 – Examine solubilisation of proteins from their cellular and extracellular locations through different grinding methods.

CO.3 – Classify the databases related to protein sequence and its structure.

CO.4 – Summarize the fundamental mechanisms of protein folding and stability and their relation to conformational diseases.

CO.5 – Demonstrate protein databases to protein sequence and structure.

Unit	Topic/ Sub Topic	Contact hours
1	Introduction to amino acids, peptides and proteins: Amino acids and their properties - hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors, Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function. Motor proteins-Actin and myosin. Defense proteins- Antibodies, Membrane proteins- Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains	12
2	Extraction of proteins for downstream processing, Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation. Separation techniques & Characterization of proteins: Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.	14

3	Three dimensional structures of proteins: Nature of stabilizing bonds - covalent and non covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns, Ramachandran map. Techniques used in studying 3-D structures -X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin.	14
4	Protein folding and conformational diseases:Prin Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamic of folding & and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based.	10
5	Introduction to Protein Databases Introduction to protein sequence and structure databases (UNIPROT, SWISS-PROT & PDB), Protein sequence file Format (FASTA) and Visualization softwares.	10

C-10: Protein (PRACTICAL)

SEMESTER –IV

PRACTICAL	Subject Code: BSBCP410CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO 1- Demonstrate assay for protein by various methods.
CO 2- Demonstrate effect of physical parameters effect on different samples containing proteins.
CO 3- Illustrate protein leakage experiment by various methods.
CO 4- Practice amino acids analysis by different chromatographic techniques.
CO 5- Illustrate isoelectric principle by casein protein.
CO 6- Demonstrate salt fractionation of crude homogenate from various samples.
CO 7- Analyze protein by SDS-PAGE.
CO 8- Experiment of separation techniques for protein by chromatography.
CO 9- Examine molecular visualization of various Biomolecules by software.

S.No.	List of Experiments	Contact hours
1	Estimation of proteins by Biuret/Lowry method/Bradford method	2
2	Effect of temperature and pH on various functionally important Proteins	2
3	Protein leakage analysis	3
4	Different Amino acid analysis by paper chromatography (ninhydrin reagent)	6
5	Isoelectric pH of casein.	3
6	Ammonium sulphate fractionation of crude homogenate from germinated mung beans	5
7	SDS-PAGE analysis of proteins	5
8	Separation of proteins using anion-exchange chromatography.	2
9	Molecular Visualization Softwares: Pymol and Rasmol for protein structures from PDB	2

Reference Books:

- Lehninger , Principles of Biochemistry: Nelson, D. L. & Cox, M.M., W.H. Freeman & Company, N.Y., USA. 5th Ed. 2008.
- Biochemistry: Voet, D. &Voet, J.G., John Wiley & Sons, Inc. USA, 3rd Ed. 2004.
- Fundamentals of Enzymology: The Cell & Molecular Biology of Catalytic protein: Price,N. C. & Stevens, L., Oxford University Press Inc. 3rd Ed. 1996.
- Biochemistry: Satyanarayana U. & Chakrapani U., Elsevier 4th 2016.
- Biochemistry: Voet, D. and Voet, J.G., John Wiley & Sons, Inc. USA. 3rd Ed. 2004.

C-11: Genetic Engineering & Biotechnology
SEMESTER V

THEORY	Subject Code: BSBCT511CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction of both the principles and application of molecular and genetic engineering. The module aims to understand the mechanisms of living, from the molecular basis of cell function to the integrated behaviour of the whole body.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Compute the basic steps of genetic engineering according to the species.
CO.2 – Modify the DNA recombinant molecules according to the target cell.
CO.3 – Apply the knowledge of DNA sequencing while genetic engineering.
CO.4 – Convert the genetic information into cDNA library and genomic library that would be beneficial for the preparation of transgenic organisms.
CO.5 – Choose the appropriate gene delivery system for the target cell.

Unit	Topic/ Sub Topic	Contact hours
1	Introduction to Genetic Engineering: Milestones in genetic engineering and biotechnology, Restriction modification systems: types i, ii and iii. Mode of action, nomenclature, applications of type ii restriction enzymes in genetic engineering, Analysis of restricted DNA: agarose gel electrophoresis and southern blotting, DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyltransferase, kinases and phosphatases, and ligases, Cloning: use of linkers and adaptors, Transformation of DNA: By chemical method.	14
2	Vectors: Cloning vectors: definition and properties, Plasmid vectors: pBR322 and pUC8, pGEM3Z series, Cloning based vectors λ bacteriophage and M13, Cosmids, BACs, YAC Expression vectors: *E. coli* lac and t7 promoter-based vectors, yeast YIP, YEP and YCP vectors, baculovirus based vectors mammalian sv40-based expression vectors. Vectors for yeast, Ti-plasmid, and retroviral vectors, high capacity vectors BAC and YAC	14
3	DNA Amplification And DNA Sequencing: PCR: basics of PCR, rt-PCR, real-time PCR, Sanger's method of DNA sequencing: traditional and automated sequencing Primer walking and shotgun sequencing.	10
4	Construction and screening of genomic and cDNA libraries,Genomic and cDNA libraries: preparation and uses, Screening of libraries: colony hybridization and colony PCR, Chromosome walking and chromosome jumping.	11
5	Applications of DNA Technology: Gene delivery: microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Products of recombinant DNA technology: products of human therapeutic interest - insulin, hGH, factor VIII. Recombinant vaccines. Gene therapy (SCID), Applications in agriculture – *Bt* cottonglyphosate herbicide resistant crops, ethical concerns.	11

C-11: Genetic Engineering & Biotechnology (PRACTICAL)
SEMESTER –V

PRACTICAL	Subject Code: BSBCP511CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate isolation of nucleic acid from microorganisms.

CO. 2- Demonstrate digestion reaction in nucleic acids of various samples.

CO. 3- Illustrate PCR methods.

CO. 4- Sketch Complementation by various techniques.

CO. 5- Illustrate hyper expression of poly histidine-tagged recombinant protein and purification.

S.No.	List of Experiments	Contact hours
1	Isolation of plasmid DNA from *E. coli* cells	5
2	Digestion of plasmid DNA with restriction enzymes	5
3	Amplification of a DNA fragment by PCR	5
4	Complementation of β-galactosidase for Blue and White selection	7
5	Hyper expression of poly histidine-tagged recombinant protein and purification using Ni–affinity resin	8

Recommended Books:

- Gene Cloning & DNA Analysis: Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), 6th Ed. 2010.
- Principles of Gene Manipulation & Genomics Primrose: S. B., and Twyman, R. M., Blackwell publishing (Oxford, UK), 7th Ed. 2006.
- Molecular Biotechnology: Principles &Applications of Recombinant DNA: Lick B. R., Pasternak, J. J. and Patten, C. L., ASM Press (Washington DC), 4th Ed. 2010.
- Molecular Cloning: A laboratory manual: Michael R. Green & J. Sambrook Cold spring Harbor laboratory press, 4th Ed. 2014.

C- 12: Hormone Biochemistry

SEMSTER -V

THEORY	Subject Code: BSBCT512CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of hormones and their functions. The module also gives insight to importance of hormones.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe the functions, regulation, classification, transport and chemical signalling mechanisms of hormones as well as hormone therapy and endocrine methodology.

CO.2 – Describe the physiological and biochemical actions as well as endocrine disorders of hypothalamic hormones and pituitary hormones.

CO.3 – Explain the biosynthesis, regulation, physiological and biochemical action as well as the pathophysiology of thyroid hormone.

CO.4 – Explain the PTH, Vitamin D, calcitonin, mechanism of Ca^{2+} regulation and pathway as well as the pathophysiology of the parathyroid gland.

CO.5 – Describe the regulations, physiological and biochemical actions as well as the pathophysiology of pancreatic and GI tract hormones.

Unit	Topic/ Sub Topic	Contact hours
1	Introduction to endocrinology: Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms, Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology. Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca2+, Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin and Ras - MAP kinase cascade. Non receptor tyrosine kinase-erythropoietin receptor JAK - STAT pathway. Steroid hormone Receptor. Receptor regulation and cross talk.	12
2	Hypothalamic and pituitary hormones: Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.	12
3	Thyroid hormone: Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological andbiochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema,Hashimato's disease.	12
4	Hormones regulating Ca 2+ homeostasis: PTH, Vitamin D and calcitonin. Mechanism of Ca2+ regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.	12

5	Pancreatic and GI tract hormones: Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipolectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II. **Reproductive hormones:** Male and female sex hormones. Interplay of hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone based contraception. Understand conditions like ammenorrhea, menorrhagia, PMS, PCOS, Menopause	12

C-12: Hormone Biochemistry (PRACTICAL)

SEMESTER –V

PRACTICAL	Subject Code: BSBCP512CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course objective: This practical is intended to describe the studentsmolecular, biochemical and physiological effects of all hormones and factors on cells and tissues.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate glucose tolerance test.

CO. 2- Illustrate various important ions of different samples.

CO. 3- Illustrate thyroid hormones in blood sample.

CO. 4- Sketch pregnancy test.

CO. 5- Illustrate hyper expression of poly histidine-tagged recombinant protein and purification.

CO. 5- Interpret the data collected from various case studies.

S.No.	List of Experiments	Contact hours
1	Glucose tolerance test.	4
2	Estimation of serum Ca2+	3
3	Estimation of serum T4	5
4	HCG based pregnancy test.	6
5	Estimation of serum electrolytes.	6
6	Case studies	6

Recommended Books:

- Lehninger Principles of Biochemistry: Nelson, D. L. & Cox, M.M., W.H. Freeman & Com. 4th Ed. 2005.
- Vander,Sherman,Luciano's Human Physiology, The Mechanism of Body Function: Widmaier, E.P.,Raff, H. and Strang, K.T., McGraw- Hill Higher Education. 9th Ed.2008.
- Molecular Cell Biology: Darnell, J., Lodish, H. & Baltimore, D., Scientific American Books, Oxford . 2008.
- Anatomy & Physiology: Gerard J. Tortora and Bryan Derrickson: Willey, Indian Edition. 2016.

C- 13: Immunology
SEMSTER -VI

THEORY	Subject Code: BSBCT613CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of immunity of the body and how it works. The module also gives insight to importance of immunity.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe cells and organs of the immune system.

CO.2 – Explain innate immunity, cell adhesion molecules, cytokines and complement system.

CO.3 – Describe the structure of antibody, B-cell development, receptor diversity and humoral immune response.

CO.4 – Explain the T-cell biology and MHC restriction.

CO.5 – Describe mucosal immune system.

Unit	Topic/ Sub Topic	Contact hours
1	Cells and organs of the immune system, : hematopoiesis, HSC, Hematopoietins and the role of Stromal cells in blood cell formation,structure and function of primary and secondary lymphoid tissues and organs; lymphatic circulation	15
2	Innate immunity: cells and soluble mediators of innate immunity, induced innate response and acute phase proteins; acute inflammatory response, Complement system, biological consequences of activation and complement regulatory proteins. Adaptive immunity: salient features, clonal selection theory, collaboration between adaptive and innate immunity,Autoimmunity: organ specific and systemic, induction of autoimmunity, immunodeficiency	15
3	Cell mediated immune response : B cell development and maturation, T cell development and maturation,antibody and its types, antigen antibody interaction	12
4	Transplantation immunology: Typing of tissues, characteristics of graft rejection, immunosuppressive Therapy, Vaccines - active and passive immunization, types of vaccines	9
5	Techniques used in immunology: antigen antibody interaction, ELISA and types, RIA, Immunofluorescence and immunoprecipitation Hypersensitivity: Gellnad Coombs classification, autoantigen and harmful antigen	9

C-13: Immunology (PRACTICAL)
SEMESTER –VI

PRACTICAL	Subject Code: BSBCP613CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Apply the isolation of blood cells from various samples or tissues.
CO.2 – Demonstrate purification process of antibodies from various types of sample.
CO.3 – Analyze precipitation reaction by different methods.
CO.4 – Examine the agglutination reactions by different methods.
CO.5 – Examine the reaction of antigen –antibody.
CO.6 – Analyze immunodiffusion reaction by various methods.

S.No.	List of Experiments	Contact hours
1	Isolation of lymphocytes from blood / spleen.	2
2	Purification of immunoglobulins	2
3	Assays based on precipitation reactions - Ouchterlony double immunodiffusion (DID) and Mancini radial immunodiffusion (SRID)	3
4	Assays based on agglutination reactions - Blood typing (active) & passive agglutination. 1.Latex Agglutination, 2.Bacterial Agglutination	6
5	Enzyme linked immunosorbent assay (ELISA) & DOT ELISA	5
6	Immunodiffusion	7

Recommended Books:

- Pathology Practical Book: Harsh Mohan, Japee Brothers Medical Publishers, Indain Edition 2002.
- Experiments in Microbiology, Plant Pathology and Biotechnology: Aneja, K.R., New Age International Publishers. 2015.
- Kuby Immunology: Kindt, T.J., Goldsby, R.A. & Osborne, B.A., W.H. Freeman & Co, New York, 2007.
- Janeway's Immunobiology, Garland Science: Murphy, K, Travers, P. and Walport, M.,Taylor & Francis Group, LLC. 2008.

C- 14: Food Biochemistry
SEMSTER -VI

THEORY	Subject Code: BSBCT614CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of food and nutrition. The module also gives insight to importance of dietary component to healths.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe the concepts in nutritional biochemistry that are important for an understanding of human nutrition.
CO.2 – Explain digestion and absorption of carbohydrates.
CO.3 – Explain the biochemical underpinning of human nutrition in maintaining health.
CO.4 – Demonstrate the biochemical basis of essentiality of macro and their nutritional deficiencies.
CO.5 –Illustrate Food-drug interactions and nutraceuticals.

Unit	Topic/ Sub Topic	Contact hours
1	Introduction to Nutrition and Energy Metabolism: Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure. Direct and Indirect Calorimetry, factors affecting thermogenesis, energy utilization by cells, energy output – Basal and Resting metabolism,physical activity, factors affecting energy input - hunger, appetite, energy balance Energy expenditure in man. Estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.	15
2	Dietary carbohydrates and health: Review functions of carbohydrates. Digestion, absorption ,utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.	14
3	Minerals: Calcium, Phosphorus and Iron - Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Calcium: Phosphorus ratio, Role of iron in prevention of anemia. Iodine and iodine cycle. Iodine, Fluoride, Mg, Cu,Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources	14
4	Fat and water soluble Vitamins, RDA, Adsorption, Distribution, Metabolism and excretion(ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid modifications. Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate.Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms.	10
5	Food-drug interactions and Nutraceuticals: Nutrient interactions affecting ADME of drugs. Drug induced nutrient deficiency:Alcohol,Antibiotics, Antimalarial drugs. Food as medicine: turmeric, garlic, ginger, cumin, asafoetida	7

C-14: Food Biochemistry (PRACTICAL)

SEMESTER –VI

PRACTICAL	Subject Code: BSBCP614CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Apply the biochemical parameters for lipids in and different types of fats.
CO.2 – Demonstrate the antioxidant enzymes from various types of sample.
CO.3 – Analyze vitamin and minerals by different methods in food samples.
CO.4 – Examine physical and biochemical components by different methods in food samples.
CO.5 – Examine the protein present in food items.
CO.6 – Analyze polysaccharides present in food samples by various methods.
CO.7 – Analyze lipids present in food samples by various methods.
CO.8 – Analyze the biochemical and physical parameters after taking food in various animals.

S.No.	List of Experiments	Contact hours
1	To acquire training to determine saponification value and iodine value of oil and different types of fats.	4
2	Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate	4
3	Estimation of vitamin and minerals in drugs/food/serum.	4
4	Nutritive value, Moisture content and Adulterants in foods	4
5	Isolation of gluten protein from Different sources	6
6	Isolation of starch from potatoes	3
7	Separation of Oil from oil seeds.	2
8	Case studies.	3

Reference Books:

- Lehninger Principles of Biochemistry: Nelson D. L. & Cox M. M., W.H. Freeman & Company, 5th Ed. 2008.
- Biochemistry: Voet, D. & Voet J. G., John Wiley & Sons, 3rd Ed. 2004.
- Fundamentals of Biochemistry: Jain J. L., Sanjay Jain & Nitin Jain. New Delhi: S. Chand & company Ltd., 6th Ed. 1997.
- Biochemistry: Campbell M. K., Published Cengage Learning., 7th Ed. 2012.
- Biochemistry Illustrated: Campbell P. N. & Smith A. D., Published by Churchill Livingstone. 4th Ed. 2011.
- Biochemistry: Satyanarayan U. & Chakrapani U., Elsevier, 4th Ed. 2016.

DSE-1: Plant Biochemistry

SEMESTER –V

THEORY	Subject Code: BSBCT501DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to Photosynthesis, Nitrogen metabolism, plant diseases and plant hormones.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Define the biochemical processes and metabolic pathways, including photosynthesis, photorespiration in plants.
CO.2 – Describe the physiological and biochemical reaction involved in cell wall biosynthesis, nitrogen fixation and assimilation.
CO.3 – Summarize the biosynthesis, regulation, physiological and biochemical action of plant hormones.
CO.4 – Explain various diseases and defence mechanism in plant.
CO.5 – Illustrate the synthesis, physiological and biochemical actions of plant secondary metabolism.
CO.6 – Apply plant tissue culture and its importance in various fields for development of new crops.

Unit	Topic/ Sub Topic	Contact hours
1	PHOTOSYNTHESIS: Significance of photosynthesis, Ultrastructure of chloroplast, photosynthesis, Photosynthetic pigments. Light absorption phenomenon, Photosynthesis in C_3 and electron transport, Photophosphorelation: Photorespiration, CAM. Bacterial photosynthesis, photochemistry and electron transport and CO_2 fixation.	12
2	NITROGEN METABOLOSIM: Metabolism of N- compound in plants, biological nitrogen cycle, nitrogenase structure and function, nitrate reduction,nitrification denitrification, symbiotic and non symbiotic nitrogen fixation, Nif-gene- organization, function and regulation, Assimilation of fixed nitrogen by plants.	10

3	PLANT HORMONES: Definition of phyto hormones, Auxins, biochemistry and mode of action of auxin, Gibberellin, Cytokinins and other natural growth hormones in plants (ethylene, abscissic acid).Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress (insects and diseases).	12
4	Respiration: Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.	8
5	SECONDARY METABOLISM IN PLANTS: Phenolic metabolism shikimate and phenyl propanoid pathways, flavonoids, lignins, and anthocyanins. Isoprenoid metabolism, terpenoids and carotenoids, alkeloids, cyanogenic glycosides and non protein amino acids. Micro and Macro nutrient deficiency in plants (biochemical role of inorganic ions in plants)	9
6	Plant tissue culture and biotechnology: Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways,organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation. Germplasm storage and cryo- preservation. Brief introduction to transgenic plants.	9

DSE-1: Plant Biochemistry (PRACTICAL)

SEMESTER –V

Practical	Subject Code: BSBCP501DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate the experiments related to photosynthesis of plant.
CO. 2- Practice quantification of various plant pigments by photometry.
CO. 3- Illustrate hydrolytic enzymes from various plant samples.
CO. 4- Sketch quantification steps for the Ascorbic Acid by various methods.
CO. 5- Illustrate quantification of secondary metabolites in various plant samples.
CO. 6- Employ the extraction of enzyme from plant samples.
CO. 7- Demonstrate the methods for culturing the plants.

S.No.	List of Experiments	Contact hours
1	Photosynthesis related experiments	4
2	Chlorophyll estimation by colorimeter	4
3	Induction of hydrolytic enzymes proteinases /amylases/lipase during germination	5
4	Vitamin C (Ascorbic Acid) estimation by titration method	4
5	Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables.	4
6	Extraction and assay of urease from Jack bean	4
7	Culture of plants (explants)	5

Recommended Books:

- Plant Biochemistry: Hans-Walter Heldt & Heldt, 4th Ed. 2010.
- Biochemistry & Molecular Biology of Plant: Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones, 2nd Ed. 2015.
- Plant Biochemistry: Dey P. M. Harbone J. B., 1st Ed. 1997.
- Advances In Plant Biochemistry: K.N. P. Singh, Agrotech Press, 2014.
- Cell Biology: Powar C.B., Himalaya Publishing House Mum, 2015.

DSE-2: Molecular Basis of Infectious Diseases

SEMESTER –V

THEORY	Subject Code: BSBCT502DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module will cover the concept of emergence and re-emergence of diseases and idea of bio-terrorism and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Define infectious diseases and Safety measure from them.

CO.2 – Describe the strategies for management of infectious diseases.

CO.3 – Summarize bacterial virulence factors and host pathogen interactions.

CO.4 – Explain various viral virulence factors and host pathogen interactions.

CO.5 – Illustrate the diseases caused by Parasites.

CO.6 – Illustrate the diseases caused by fungi.

Unit	Topic/ Sub Topic	Contact hours
1	**Infectious diseases: an introduction:** Classification of infectious diseases, Nosocomial infections; Patterns of Disease; Measuring infectious disease frequency; Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens. Safety measure when working with pathogen biosafety levels, infection and evasion	7
2	**Strategies for management of infectious diseases:** Role of drugs, vaccines, hygiene and sanitation in prevention, transmission control and treatment of infectious diseases	4
3	**Diseases caused by bacteria:** Classification of bacterial pathogens based on structure and nutritional requirements; Overview of bacterial virulence factors and host pathogen interactions; Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, diagnostics, therapeutics and vaccines, drug resistance and implications on public health. Other bacterial diseases - virulence factors, host pathogen interaction, symptoms, diagnosis, vaccines and drugs against - Typhoid, Diphtheria, Pertussis, Tetanus,Botulism Cholera, Anthrax and Pneumonia	20
4	**Diseases caused by Viruses:** Structure of viruses, Baltimore system for virus classification; Overview of viral virulence factors and host pathogen interactions; Detailed study of AIDS: history, causative agent, pathogenesis, diagnostics, drugs; Other viral diseases including hepatitis, Influenza (Antigenic shift and antigenic drift), Rabies, Dengue and Polio; Chicken Pox, Herpes Virus	15
5	**Diseases caused by Parasites:** Detailed study of Malaria: history, causative agents, vectors, life cycle, Host parasite interactions, diagnostics, drugs, vaccine development. Other diseases including Leishmaniasis and Amoebiasis, Giardiasis and Trypanosoma infections	8
6	**Diseases caused by Fungi:** Fungal diseases such as Candidiasis, Sporotrichosis, Aspergillosis and Ring worm: general disease characteristics, medical importance, pathogenesis, diagnosis and treatment.	6

DSE-2: Molecular Basis of Infectious Diseases (PRACTICAL)

SEMESTER –V

PRACTICAL	Subject Code: BSBCP502DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Illustrate bacteriophages (PFU) from different water/sewage sample.

CO.2 – Practice different types of staining techniques using in different microorganism identification.

CO.3 – Demonstrate various slides of microorganism.

CO.4 – Calculate MIC by using different assay.

CO.5 – Outline the current trends in infectious disease.

Unit	List of Experiments	Contact hours
1	Isolation and enumeration of bacteriophages (PFU) from water/sewage sample	6
2	Gram staining, Fungal staining, Acid fast staining	5
3	Permanent slides of pathogens: Mycobacterium tuberculosis, Leishmania, Plasmodium falciparum	5
4	MIC determination using Kirby Bauer / Alamar Blue assay	6
5	Research and presentation on current trends in infectious diseases	8

Recommended Books:

- Biochemistry With Clinical Concepts And Case Studies: Satyanarayana, U & Chakrapani, U, Elsevier India PVT LTD, 4th Ed. 2016.
- Pharmaceutical Chemistry: Chatwal G. R. & Arora M., Himalaya Publishing House Mum. 5th Ed. 2017.
- Textbook of Medical Biochemistry: Chatterjea M. N. & Rana Shinde, Jaypee Brothers, New Delhi, 7th Ed. 2007.

DSE-3: Scientific Methodology & Technical Writing

SEMESTER –V

THEORY	Subject Code: BSBCT503DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The student will learn about all the techniques involved in the formulation of a research project and writing of a scientific paper.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Distinguish between types of research methodologies.

CO.2 –Describe the process of research design.

CO.3 – Describe the process of formulating a hypothesis.

CO.4 – Distinguish between types of report and its layout.

Unit	Topic/ Sub -Topic	Contact hours
1	Ressearch Methodology, Introduction & types,y. Types of research –Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Literature survey Importance & Primary and secondary sources	20
2	Research Design, Basic principles, Characteristics of a good design.	12
3	Formulation of hypothesis, Meaning, Techniques and Precautions of Interpretation.	10
4	Research Report Writing, Structure and components of scientific reports, Types of report,Different steps in the preparation –Layout, structure and Language of typical reports – Illustrations and tables , Bibliography,referencing and footnotes. Research paper writing- Main components and structure.	18

DSE-3: Scientific Methodology & Technical Writing (PRACTICAL)

SEMESTER –V

PRACTICAL	Subject Code: BSBCP503DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1- Demonstrate review writing skills.

CO.2- Demonstrate report writing skills.

CO.3- Demonstrate abstract writing skills.

CO.4- Demonstrate scientific proposal writing skills.

Unit	List of experiments	Contact hours
1	Review writing	8
2	Report writing	8
3	Abstract writing	6
4	Scientific proposal writing	8

Recommended Books:

- Research Methodology Logic methods and cases: Sameer Phanse, Oxford University Press, 2016.
- Successful Scientific writing: Janice Mathews, Robert Mathews & John M. Bowen, Cambridge University Press, 2nd Ed. 2000.

DSE-4: Biochemical Applications in Forensics

SEMESTER –V

THEORY	Subject Code: BSBCT504DE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidences, which will help students develop analytical and problem solving skills for real life situation. The course will keep abreast with all recent developments and emerging trends in forensic science thus helping interested students take up forensic science as future course of study.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Define basic principle, significance of forensic science and preservation of biological evidence and its importance.

CO.2 – Discuss various biological evidence of animal and human by various case studies.

CO.3 – Examine toxicants, drugs and narcotics in biological samples.

CO.4 – Analyze recent advances in forensics that includes RFLP, STR, and PCR.

Unit	Topic/ Sub –Topic	Contact hours
1	**Introduction to forensic sciences:**Basic Principles and Significance; History and Development of Forensic Science; Defining the scene of investigation; Collection, Packaging, Labelling and Forwarding of biological exhibits to forensic laboratories; Preservation of biological evidence; Importance of Health and Safety Protocols in sample collection and analysis.	10
2	**Biological science and its application in investigation :** Biochemical analysis of various biological evidence like blood, semen & other biological fluids, viscera, bite marks, hair (animal and human), fibres & fabrics, pollen and soil; Establishment of identity of individuals - fingerprints, footprints, blood and DNA analysis, anthropology – skeletal remains, Odontology; Time of death- rigor mortis, liver mortis, algor mortis, forensic entomology. Biochemical basis for determination of cause of death, case studies	20

3	**Chemical science and its application in investigation:**Detection of drugs of abuse and narcotics in biological samples; Toxicological examination of viscera,detection ofpetroleum products, food adulteration; Analysis of inks and their use inquestioned document identification, blood splatter analysis, stain analysis, case studies.	15
4	**Recent advances in forensics.:***Narco analysis*: theory, forensic significance, future prospect; *Brain mapping:* introduction, EEG, P-3000 wave, forensic applications, limitation of technique; *Polygraph*: Principle and technique, polygraph as forensic investigative tool, use of psychoactive drugs in forensic analysis. NHRC guidelines for polygraph test; *Facial reconstruction*: Method and technique, facial reconstruction in forensic identification; DNA Finger Printing; DNA-Introduction, source of DNA in Forensic case work, Extraction of DNA, Techniques of DNA fingerprinting-RFLP, STR, PCR. DNA fingerprinting in paternity disputes, mass disaster andother forensic case work, case studies	15

DSE-4: Biochemical Applications in Forensics (PRACTICAL)

SEMESTER –V

PRACTICAL	Subject Code: BSBCP504DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Apply chromatography method for differentiation among drugs.
CO.2 – Demonstrate development of fingerprints from various surfaces.
CO.3 – Analyze natural variations in handwriting characters.
CO.4 – Examine of Hair/Fibre/Pollen/diatom by microscope.
CO.5 – Examine blood grouping, DNA finger printing.
CO.6 – Identify various drug in urine samples.
CO.7 – Analyze the data by make a trip to forensic laboratories.

Unit	List of Experiments	Contact hours
1	TLC method for differentiation of ink/drugs	5
2	Fingerprint development from various surfaces	2
3	Handwriting identification based on class characteristic and individual characteristics	2
4	Microscopic examination of Hair/Fibre/Pollen/diatom	5
5	Examination of blood samples: Blood grouping, DNA finger printing, Blood splatter analysis	4
6	Examination of urine samples: Identification of drugs	4
7	Field trip to a forensic laboratory.	8

Recommended Books:

- Parikh's Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology: Parikh C.K., CBS Publishers & Distributors, 6th Ed. 2007.
- Henry Lee's Crime Scene Handbook: Henry C Lee, Timothy Palmbach, Marilyn T. Miller, Elsevier Acadmic Press, 2001.
- Forensic Biology: Shrikant H. Lade, Elsevier Acadmic Press, 1st Ed. 2001.
- Crime Scene Processing and Laboratory Work Book: Patrick Jones, Ralph E. Williams, CRC Press, Taylor & Francis Group, 2009.
- Forensic Science: An Introduction to Scientific and Investigative Techniques: Stuart H. James, Jon J. Nordby, CRC Press, Taylor & Francis Group, 2nd Ed. 2005.

DSE-5: Cancer Biology
SEMESTER –VI

THEORY	Subject Code: BSBCT605DE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidences, which will help students develop analytical and problem solving skills for real life situation. The course will keep abreast with all recent developments and emerging trends in forensic science thus helping interested students take up forensic science as future course of study.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Describe various stages of development of the tumor
CO.2 – Define mechanism of carcinogenic transformation by oncogenes.
CO.3 – Discuss stages in chemical and physical carcinogenesis
CO.4 – Identify various tumor markers and signaling pathway.
CO.5 – Discuss cancer diagnosis through various strategies and techniques

Unit	Topic/ Sub –Topic	Contact hours
1	**Introduction:** Growth characteristics of cancers cells; neoplasia, anaplasia, metaplasia and hyperplasia, types of cancer benign, malignant, metastatic cancers. Carcinomas, sarcomas, adenomas, haemopoetic cancers. Characteristics of cancer cells, changes in cell membrane structure and functions.	12
2	**Oncogenes:** Provirus, protovirus, oncogenes and proto oncogenes. Mechanism of carcinogenic transformation by oncogenes, viral oncogenes. Tumor suppressor genes - properties, mechanism of tumor suppressor genes in cancer induction with special reference to P53 gene	12
3	**Carcinogenesis:** Principles of carcinogenesis- chemical carcinogenesis, stages in chemical carcinogenesis - Initiation, promotion and progression. Physical carcinogenesis – X-ray radiation. Viral carcinogenesis. Free radicals and antioxidants in cancer.	12
4	**Tumour markers:** Tumour markers- types of tumour markers. Apoptosis in cancer Cell death by apoptosis role of caspases . Death signaling pathways mitochondrial and death receptor pathways.	12
5	**Diagnosis and Treatment:** Cancer screening diagnosis and treatment. RIA and ELISA.Strategies of anticancer drug therapy chemotherapy , gene therapy, Immunotherapy and radiotherapy.	12

DSE-5: Cancer Biology (PRACTICAL)
SEMESTER –VI

PRACTICAL	Subject Code: BSBCP605DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Demonstrate the cell division study in different samples.
CO.2 – Demonstrate the effect of inhibitors of cell division from various types of sample.
CO.3 – Analyze noncancerous condition by different methods in samples.
CO.4 – Examine tumor marker by different methods in samples.
CO.5 – Examine the mutagenesis present in microorganism.
CO.6 – Analyze characteristics of the tumor imaging photographs.
CO.7 – Analyze the tumour and its consequences in cancerous patient.

Unit	List of Experiments	Contact hours
1	Study of mitosis	3
2	Study of cell cycle inhibitors	3
3	Blood Analysis:Blood in the urine hematuria) may be the result of a benign (noncancerous) condition	3
4	Tumor Marker	5
5	Mutagenesis induced by UV rays in microorganism	5
6	Study of characteristics of the tumor imaging photographs	4
7	Case Study	7

Recommended Books:

- Biochemistry With Clinical Concepts And Case Studies: Satyanarayana, U & Chakrapani, U, Elsevier India PVT LTD, 4th Ed. 2016.
- Pharmaceutical Chemistry: Chatwal, G. R., Arora, M., Himalaya Publishing House Mum. 5th Ed. 2017.
- Textbook of Medical Biochemistry: Chatterjea M. N. & Rana Shinde. Jaypee Brothers, New Delhi, 7th Ed. 2007.

DSE-6: Biophysics

SEMESTER- VI

THEORY	Subject Code: BSBCT606DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The course aims to provide students with a foundation in the basic concepts of Biophysics. Topics will include canonical and non-canonical structures of nucleic acids, structure of proteins, enzymes etc. Basic ideas of diffusion, thermodynamics and kinetics will be discussed in the context of biological processes.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe basic concepts of biophysics.

CO.2 – Discuss canonical and non-canonical structures of Biomolecules

CO.3 –Explain basic ideas of diffusion, thermodynamics and kinetics in the context of biological processes.

CO.4 –Differentiate working principle, instrumentation and applications of various bio-analytical instruments.

CO.5 – Outline formation and diffusion pattern of stripes on animals

Unit	Topic/ Sub-Topic	Contact hours
1	Thermodynamics of living systems: Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Coupled reactions.	12
2	Co-operative transitions -Protein folding: Forces for protein stability, Protein denaturation and renaturation, Protein folding pathways, Levinthal's paradox, Molten globule, Folding accessory proteins, Prediction of protein structures, Protein Function: Structure of heme, Structure of Myoglobin and hemoglobin, Oxygen binding mechanism, Oxygen binding co-operativity, Hill equation, Hill coefficient, Allostery in hemoglobin, Bohr effect. Unzipping of DNA	12
3	Dynamics of biomolecules: Diffusion, Laws of diffusion, Active transport, Facilitated diffusion, Osmosis, Osmotic pressure, Osmoregulation, Viscosity and biological importance, Surface tension, Factors influencing surface tension, Biological importance.	12
4	Physical Techniques and related biology-X-ray diffraction, light and neutron scattering, Nuclear magnetic Resonance, Fluorescence', DNA Microarrays, Manipulation of bio-molecules using optical tweezers. Tomography, Patch clamps.	12
5	Pattern formation and diffusion- How nonlinear partial differential equations produce patterns. Cheetah stripes on the tail and spots on the body. Instability patterns.	12

DSE-6: Biophysics (PRACTICAL)
SEMESTER –VI

PRACTICAL	Subject Code: BSBCP606DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Demonstrate the basic principles of various types of microscopes.
CO.2 – Demonstrate the effect of inorganic compound and its percent purities in various types of sample.
CO.3 – Analyze characteristics of UV absorption spectra of by different methods in samples in different biomolecules.
CO.4 – Examine quality of the lipids by different parameters.
CO.5 – Examine quantity of the nucleic acid present in the sample.
CO.6 – Analyze characteristics and quantity of protein by different methods.
CO.7 – Appraise the Chemo taxis and its consequences in cancerous patient.
CO.8 – Appraise the cell growth curve & determination of generation time.

Unit	List of Experiments	Contact hours
1	To familarize with bright field, phase contrast, fluorescence & polarizing microscopes.	4
2	To estimate the percent purities of dyes and inorganic compounds.	3
3	To study the characteristics of UV absorption spectra of Aromatic Amino Acids or nucliec acids or proteins	4
4	To analyze of Oil-Iodine number, saponification number	3
5	To estimate the DNA molecules.	4
6	To estimate proteins by Biuret assay and Folin's-Lowry method.	4
7	Demonstration of Chemo taxis.	4
8	To establish the cell growth curve & determination of generation time.	4

Recommended Books:

- Advanced Biology Statistics: Edmondson A. & Druce D., Oxford University Press, 1996.
- An Introduction to Biophysics: Moganty R. Rajeswari, Rastogi Publications-Meerut; 1st Ed.2013.
- An Introduction to Biophysics: Dr Pranab Kmar Banerjee, S Chand Publications, Revised Ed. 2014.

DSE-7: Biostatistics
SEMESTER –VI

THEORY	Subject Code: BSBCT607DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The student will learn to collect, tabulate, & analyze data as a researcher.
Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Define the principal concepts about biostatistics.
CO.2 – Compute statistical problems using computer and graphical means.
CO.3 – Solve mean and variance of discrete and continuous distribution.
CO.4 – Analyze data by sampling, collection and preservation techniques.
CO.5 – Appraise statistical tests, t-distribution, and the standard error formulas

Unit	Topic/ Sub –Topic	Contact hours
1	Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable,	14
2	Curve Fitting; Correlation and Regression	10

3	Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution	8
4	Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics	14
5	Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test;	14

DSE-7: Biostatistics (PRACTICAL)

SEMESTER –VI

PRACTICAL	Subject Code: BSBCP607DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Define the principal concepts about biostatistics.

CO.2 – Compute statistical problems using standard deviation.

CO.3 – Interpret of central tendency, Dispersion, Skewness and Kurtosis.

CO.4 – Analyze Concept of Principle of least squares for curve fitting and regression lines.

CO.5 – Appraise Concept of various correlation and regression.

CO.6 – Appraise self directed learning of unfamiliar statistical methods for results/findings.

Unit	List of Experiments	Contact hours
1	Mean, Median, Mode from grouped and ungrouped Data set	5
2	Standard Deviation and Coefficient of Variation	5
3	Skewness and Kurtosis	5
4	Curve fitting	5
5	Correlation, Regression	5
6	Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test,Confidence Interval	5

Recommended Books:

- Fundamentals of Biostatistics Study Guide: Bernard Rosner, Duxbury Thomson Learning, 5th Ed. 2000.
- Introduction to Biostatistics: Larry Winner, 2004.
- Introductory Biostatistics: Chap T. Lee & Chap Lee, Wiley, 2nd Ed. 2015.
- Understanding Calculus: Bear H. S., John Wiley and Sons, 2nd Ed. 2003.
- Introduction to Mathematics for Life Scientists: E. Batschelet, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi, 1975.
- Advanced Biology Statistics: Edmondson A. & Druce D., Oxford University Press, 1996.
- Student Edition, Narosa Publishing House, New Delhi, 1971, 1975.
- Advanced Biology Statistics: A. Edmondson and D. Druce, Oxford University Press; 1996.

DSE-8: Biosafety and Intellectual Property Rights

SEMESTER –VI

THEORY	Subject Code: BSBCT608DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module introduce basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe introduction, bio safety issues in biotechnology.

CO.2 – Define bio safety guidelines and its regulations.

CO.3 – Explain procedures involved and protection of intellectual property and related rights.

CO.4 – Discuss various grant of patent and patenting authorities.

CO.5 – Classify agreements and treaties that include GATT, UPOV etc.

Unit	Topic/ Sub –Topic	Contact hours
1	Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types;Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms	12
2	Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM,GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; RiskAnalysis; Risk Assessment; Risk management and communication; Overview of InternationalAgreements - Cartagena Protocol.	10
3	Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR –patentable and non patentables – patenting life – legal protection of biotechnological inventions –World Intellectual Property Rights Organization (WIPO). AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.	20
4	Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	10
5	Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement;WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms;UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	8

DSE8-: Biosafety and Intellectual Property Rights (PRACTICAL)

SEMESTER –VI

PRACTICAL	Subject Code: BSBCP608DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1- Identify the components of a BSL-III laboratory.

CO.2- Prepare applications for approval from biosafety committee.

CO.3- Identify the components of a BSL-III laboratory.

CO.4- Employ steps of a patenting process.

CO.5- Prepare case studies.

S.No.	List of Experiments	Contact hours
1	Study of components and design of a BSL-III laboratory	5
2	Filing applications for approval from biosafety committee	6
3	Filing primary applications for patents	6
4	Study of steps of a patenting process	5
5	A case study	8

Recommended Books:

- Indian Patent Act 1970 Acts & Rules: Universal Law Publishing Co. Pvt. Ltd., New Delhi. Bare Act, 2007.
- Genetic Patent Law & Strategy: Kankanala C., Manupatra Information Solution Pvt. Ltd. New Delhi. 1st Ed. 2007.
- Indian Patents Law: Mittal D.P., Taxmann, Allied Services (p) Ltd. 1999.
- Biotechnology & Intelectual Property Rights: Legal and Social Implications: Singh K. K. Springer India. 2015.
- IPR, Biosafety & Bioethics: Goel D. & Prashar S., Pearson, 2013.

DSE-9: Research Project

SEMESTER –VI

THEORY	Subject Code: BSBCP609DE
Total Marks for Evaluation: 100	No. of Contact Hours: 90, Credits: 6

This paper would focus on the project work/dissertation to be carried out by the students in the supervision of the teachers in the colleges. The topic of the project would be selected by each student in consultation with the teacher (Advisor). This would train the student to retrieve the literature and collate the information sufficient to make a presentation, the collated literature would also prepare the base for initiating the research. The student would carryout experiments to achieve the planned objectives, collation and analysis of data, presentation of the result in the form of a Dissertation. The grading would be based on continuous evaluation that would include punctuality, hard work, record keeping, intellectual inputs, data presentation, interpretation etc.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1 – Analyze the researchable problems and devise strategies to overcome the problems.

CO. 2 – Formulate project proposal with key indicators for monitoring the progress.

CO. 3 – Experiment the project and perform mid-term corrections as alternative strategies.

CO. 4 – Demonstrate the general conduct and discipline of working in a team environment in lab.

CO. 5 – Apply the skills of writing a research paper while preparing a thesis

GE 1- Physical Aspects of Biochemistry

SEMESTER- I

THEORY	Subject Code: BSBCT101GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of chemical system and data acquisition. The module also gives insight to importance of graphics and basic statistics of physical chemistry.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1-Define basic concepts of acid and base by Henderson -Hasselbach equation.

CO. 2- Describe various solutions and Donnan equilibrium in biological system.

CO. 3- Outline the principle of osmosis and diffusion in biological system.

CO. 4- Discuss isomerism and Intra and Intermolecular interactions in biological system.

CO. 5- Explain Basic principles of thermodynamics.

Unit	Topic/Sub-Topic	Contact hours
1	Dissociation of water, ionic product of water, concepts of pH, pOH, simple numerical problems of pH, determination of pH using indicators, pH meter and theoretical calculations, Dissociation of weak acids and electrolytes, Bronsted theory of acids and bases, shapes of titration curve of strong and weak acids and bases, Meaning of Ka and pKa values, Buffers: buffer action, buffers in biological system, Henderson -Hasselbach equation with derivation, simple numerical problems involving application of this equation.	12
2	Solutions: Definition of true solution, colloidal solution, and coarse suspension, distinction between lyophilic and lyophobic sols, Fundamental study of Donnan equilibrium-application in biological system, Methods of preparation of colloidal solution, membrane permeability, separation of colloidal solutions, elementary study of charge on colloids, Tyndall effect, application of colloidal chemistry, emulsion and emulsifying agents.	12
3	Definition of normality, molarity, molality, percentage solution, mole fractions, simple numerical problems, Fundamental principles of diffusion and osmosis, definition of osmotic pressure, isotonic, hypotonic and hypertonic solutions, Biological importance of osmosis, Relationship of osmotic pressure to gas laws, General equation for dilute solutions, influence of ionization and molecular size on osmotic pressure.	12
4	Classification of isomerism, oxidation reduction reactions, substitution, addition, elimination, condensation and decarboxylation with examples for each, Intra and Intermolecular interactions in biological system: Hydrogen bond, Covalent bond, hydrophobic interaction, disulphide bond, Peptide bonds, glycosidic bond, Phosphodiester linkage, Watson- Crick base pairings, Vander Wall's force.	12
5	Chemical kinetics : Introduction to chemical kinetics, equilibrium reactions, law of mass action, equilibrium constant, definition of catalysis, Basic principles of thermodynamics: free energy, enthalpy, entropy, reversible and irreversible reactions- as applied to biological systems.	12

GE-1: Physical Aspects of Biochemistry (PRACTICAL)

SEMESTER –I

PRACTICAL	Subject Code: BSBCP101GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Discuss safety measure in laboratories.

CO. 2-Summarize the concept of pH by various buffer.

CO. 3- Summarize the concept of pH by various buffer.

CO. 4- Employ specific rotation of the molecules in aqueous solution.

CO. 5-Prepare various types of solutions.

S. No.	List of Experiments	Contact Hours
1	Safety measure in laboratories, use and calibration of pipettes	6
2	Concept of pH and preparation of buffers.	6
3	Formol titration (acidic, basic, neutral amino acid)	8
4	Determination of specific rotation of a given optically active compound and %composition of its aqueous solution using Polarimeter	5
5	Preparation of normal, molar and percent solutions	5

Recommended Books:

- Biometerials: Bhat, Sujata V., Narosa Publishing House, 2010.
- Principles of Physical Biochemistry: Vanholde & Johnson, P. Shing, Pearson Prentice Hall Upper Saddle River, New Jersey, 2nd Ed. 2005.
- Physical Biochemistry: Principles and Applications: David Sheehan, Wiley, 2nd Ed. 2009.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology, David, M. Freifelder, ACS publication, 1983.

GE-2: General and Organic Chemistry

SEMESTER –I

THEORY	Subject Code: BSBCT102GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course gives firm foundations in the fundamentals and application of current chemical and scientific theories.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1 – Describe fundamental principles of current chemical and scientific theories.

CO. 2 – Define factors affecting solubility, dilution factor and solute – solvent interaction.

CO. 3 – Discuss various intermolecular forces and bond among molecules.

CO. 4 – Explain reaction rate and reaction kinetics.

CO. 5 – summarize laws of radioactivity and application of radioactive isotopes.

Unit	Topic/Sub Topic	Contact hours
1	**Atomic Structure:** Concept of atomic orbital, shapes of s, p and d orbitals, radial and angular probability of s, p and d orbitals (qualitative idea). Many electron atoms, Pauli Exclusion Principle, Hund's rule of maximum multiplicity, exchange energy, Aufbau (building up) principle and its limitations, Electronic energy levels and electronic configurations of hydrogen like and polyelectronic atoms and ions (concept only), Ground state term symbols of atoms and ions (concept only).	12
2	Solutions, types of solutions, solvation energy, lattice energy, Equivalent & molecular mass, mole concept, solubility & factors affecting solubility, Expression for concentration of solutions ,polarity of solvents, Importance of dielectric constant of solvents ,solvents other than water, classification of solvents ,Dilution factor, serial dilution, Solute–solvent interactions in solutions.	12
3	**Intermolecular forces**: **a. Ionic bonding:** Size effects- radius ratio rules and their limitations. Packing of ions in crystals, Lattice energy, Born-Lande equation and its applications. **b. Covalent bonding:** Lewis structures, formal charge, Preliminary idea of Valence Shell Electron Pair Repulsion (VSEPR) Theory, Partial ionic character of covalent bonds, bond moment and dipole moment, Partial ionic character from dipole moment values and electro negativity differences. Directional character of covalent bonds, hybridization, equivalent and non equivalent hybrid orbital, Bent's rule; Concept of resonance, resonance energy, resonance structures. bonding, non-bonding, antibondingmolecular orbitals. Concept of Bond order, bond length, bond strength, bond energy. C. **Weak Chemical Forces**: Van der Waal's forces, ion-dipole, dipole–dipole interactions, London forces, Hydrogen bonding; Effect of chemical forces on physical properties d. Co-ordination compounds: Double salts and complex salts, Isomerism of co-ordination compounds: Constitutional, geometrical and optical isomerism in respect co-ordination numbers 4 and 6. cis-,trans configuration.	12
4	Rate of reaction, differential rate law expressions,Order& molecularity, rate constant, integrated equations (Ist,2nd & 3rd order), nth life of a reaction. Arrhenius equations, temperature dependence of rate constant, energy profile diagrams. Reaction intermediates, Different theories on reaction rate. Reaction kinetics: transition state theory, rate constant and free energy of activation, free energy profiles for one step and two step reactions (concept only). Nucleophilic substitution reactions- SN1, SN2 mechanisms. Effect of substrate structure, nucleophiles and medium on reactivity and mechanism; neighboring group participations. Elimination Reactions- E1, E2 mechanisms.	12
5	Radioactivity: Laws of radioactivity, average life of radio elements and its relation with half life, properties of α,β,γ radiations, radiation damage, radiation protection and safety aspects, units of radioactivity, radioactive carbon dating. Applications of radioactive isotopes: Examples of radio isotopes (14C, 3H, 32P, 35S, 2H, 125I) and their uses in biological systems. Basic principles of liquid scintillation counter. Radiation absorption, Radiation therapy in cancer	12

GE-2: General & Organic Chemistry (PRACTICAL)

SEMESTER –I

PRACTICAL	Subject Code: BSBCP102GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1 Summarize the physical characteristics of various samples.

CO. 2- Employ the test for various elements.

CO. 3- Summarize the concept solubility of various compounds.

CO. 4- Demonstrate functional groups by systematic chemical tests in various compounds.

S.No.	List of Experiments	Contact Hours
1	Physical characteristics (colour, odour, texture)	6
2	Detection of special elements (N, Cl, S) by Lassaigne's tests.	6
3	Solubility and classification (Solvents: H2O, 5% HCl, 5% NaHCO3, 5% NaOH)	8
4	Detection of the following functional groups by systematic chemical tests: (aromatic amino (–NH2), Amido (–CONH2, including imide), aromaticnitro (– NO2), Phenolic –OH, Carboxylic acid (–COOH), Carbonyl (>C= O);only one test for each functional group is to be reported)	10

Recommended Books:

- Advanced Practical Chemistry – Subhas Ch. Das, Handbook Archeives, 2016.
- Quantitative Chemical Analysis: Mendham, J., A. I., Pearson, 6th Ed. 2009.
- Practical Organic Chemistry: Mann, F.G. & Saunders, B.C., Pearson Education, 2009.
- A Guide to Organic Reaction Mechanism: P. Sykes, Longman Scientific & Technical, Copublished with John Wiley & Sons,
- Stereochemistry of Carbon Compounds: D. Nasipuri, New Age Inernational (P) Limited Publisher, 2nd Ed. 2005.
- Basic Stereochemistry of Organic Compounds: S. Sen Gupta, Oxford, Higher Education, 2nd Ed. 2018.
- General &Inorganic Chemistry: R. P. Sarkar, NCBA, Part I, 2011.
- Inorganic Chemistry: R. L. Dutta & G. S. De, the New book Stall, 1973.
- Concise Inorganic Chemistry: J. D. Lee, Wiley, 5th Ed. 2008.

GE-3: Microbiology
SEMESTER –I

THEORY	Subject Code: BSBCT203GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60,Credits: 4

Course Objective: This module is a general introduction to the basic concepts of microbiology and their functions. The module also gives insight to importance of microbes.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Define the basic concepts of microbiology and their functions.
CO.2 – Explain cellular organization of various microorganisms
CO.3 – Classify various microorganisms on the basis of staining techniques.
CO.4 – Discuss various culture media and plating techniques for growing the microorganisms

Unit	Topic/Sub-Topic	Contact hours
1	History of Development of Microbiology: Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner	17
2	Cell Organization: Cell size, shape and arrangements, capsule, fimbriae, pili, bacterial and archaeal flagellar structures, twitching, gliding and spirochete motility, Wall: Composition and detailed structure of gram- positive and gram- negative cell wall, archaebacterial cell wall,LPS structure, sphaeroplasts, protoplasts and L-forms,Membrane: Structure, chemical composition and functions of bacterial and archaeal cell membrane, Cytoplasm: Ribosomes, inclusions, nucleoid, plasmids, bacterial cytoskeleton	16
3	Diversity of Microorganisms: Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility, General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa) giving definitions and citing examples, Protozoa : Methods of nutrition, locomotion & reproduction - Amoeba, Paramecium and Plasmodium	13
4	Culture media, Sterilization and Pure cultures- Nutritional categories: A brief overview: Culture media: Components of media, Synthetic or defined media, Complex media, supportive media, enriched media, selective media, differential media, enrichment culture, Sterilization: Physical methods of heat, filtration and radiations, Pure culture isolation: Streaking, serial dilution and plating methods. Cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria	14

GE-3: Microbiology (PRACTICAL)

SEMESTER –II

PRACTICAL	Subject Code: BSBCP203GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Explain basic lab glassware's.
CO. 2- Explain basic lab instruments for various experiments.
CO. 3- Apply serial dilution for microbial growth experiments.
CO. 4- Apply the various sterilization techniques for microbial inhibitory concentration.
CO. 5- Practice the basic culture media requires for microbial growth.
CO. 6- Practice the various plating techniques.
CO. 7- Demonstrate microbial growth by various microscopic techniques.

S.No.	List of Experiments	Contact Hours
1	Basic Lab glassware: Test tubes, screw capped tubes, pipette, Pasteur pipettes, Erlenmeyer flask, Eppendorf tubes, pipette tips, cover slip and slides.	6
2	Basic Lab instrumentation: Autoclave, incubator, Hot air oven, , Laminar air flow, bunsen burner, Electric balance, hot plate, Microscope, water bath, colorimeter	6
3	Serial dilution with indicator dye	3
4	Sterilization procedures and contamination check	3
5	Preparation of basic culture media	6
6	Plating techniques	3
7	Microscopy & Visualization of bacterial morphology	3

Recommended Books:

- Microbiology: An Introduction: Tortora G. J., Funke B. R. & Case C. L. Pearson Education, 9th Ed. 2008.
- Microbiology: Pelczar Jr. M. J., Chan E.C.S. & Krieg N. R., McGraw Hill Education (India) Private Limited, 5th Ed., 55 reprint 2016.
- Microbiology, Lansing M Prescott, The McGraw Hill Companies. 7th Ed. 2010.
- Applied Dairy and Food Microbiology: Rameshwar Singh Agrotech Publishing Academy, 2005.

GE 4- Biochemistry Laboratory

SEMESTER- II

THEORY	Subject Code: BSBCT204GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The objective of the course is to introduce various techniques to the students, which are used in biological research as well as to provide them with an understanding of the underlying principles of these techniques and experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject and better execution of these techniques.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1 – Describe various spectroscopic techniques and their application in biochemistry.

CO. 2 – Define various principles and applications of various chromatography techniques

CO. 3 – Explain principle and application of electrophoresis for various biomolecules.

CO. 4 – Discuss principle and their application of various centrifuge techniques.

CO. 5 – Explain microbiological culture, maintenance and bio safety techniques.

CO. 6 – Summarize the principle of various microscopy and microbiological staining techniques.

Unit	Topic/Sub-Topic	Contact Hours
1	**Spectroscopic Techniques:** Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry in biochemistry. Fluorescence spectrophotometry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence,applications of fluorescence in biochemistry.	15
2	**Chromatography:** Preparation of sample, different methods of cell lysis, salting out, dialysis. Introduction to chromatography. Different modes of chromatography: paper, thin layer and column. Preparative and analytical applications. Principles and applications of: Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Molecular Sieve Chromatography, Affinity Chromatography.	15
3	**Electrophoresis:** Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, isoelectric focusing of proteins.	12
4	**Centrifugation:**Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of centrifuges, low speed centrifuge, high speed centrifuge and ultracentrifuge, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation- zonal and isopycnic.	8
5	**Microbiological/Cell culture techniques:** Types of media, selective and enrichment media, sterilization methods, bacterial culturing,CFU determination, growth curves, Generation/doubling times, cell counting, viable and nonviable. Growth and maintenance of cultures, biosafety cabinets, CO2incubator. Staining procedures, plating and microtony.	5
6	**Microscopy:** Principle of light microscopy, phase contrast microscopy, fluorescence microscopy.Permanent and temporary slide preparation, histology and staining.	5

GE-4: Biochemistry Laboratory (PRACTICAL)
SEMESTER –II

PRACTICAL	Subject Code: BSBCP204GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO. 1- Explain principle of photometry.
CO. 2- Explain basic lab instruments for various experiments.
CO. 3- Apply electrophoresis for various biological components.
CO. 4- Apply the various centrifuge techniques for isolation of cell organelles.
CO. 5- Practice staining techniques for various components.

S.No.	List of Experiments	Contact Hours
1	Verification of Beer's Law	6
2	Separation of amino acid acids by TLC/paper chromatography	6
3	To perform agarose gel electrophoresis	8
4	To isolate mitochondria by differential centrifugation	5
5	Visualization of cells by methylene blue	5

Recommended Books:

- Modern Theory and Techniques, Biochemistry Laboratory: Boyer, R.F., Boston, Mass: Prentice Hall, 6th Ed. 2012.
- An Introduction to Practical Biochemistry: Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 3rd Ed. 1998.
- Principles and Techniques of Biochemistry and Molecular Biology: Wilson K. and Walker J., Cambridge University Press, 7th Ed. 2010.
- Prescott's Microbiology: J.M., Sherwood, L.M. and Woolverton, C.J., McGraw Hill Higher Education Wiley, 10th Ed. 2017.

GE 5: Intermediary Metabolism
SEMESTER- III

THEORY	Subject Code: BSBCT305GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objectives:
The objective of this course is:
1. To provide the students an understanding about the major metabolic pathways of different types of metabolism such as carbohydrates, lipids, amino acids and nucleic acid with their regulation
2. To provide the student's knowledge about the possible correlation between all metabolic pathway

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe metabolic pathways of glycolysis and gluconeogenesis.
CO.2 – Define citric acid cycle and oxidative phosphorylation in the cell.
CO.3 – Explain diseases associated with the abnormal carbohydrate metabolism.
CO.4 – Discuss fatty acid and amino acid degradation and associated diseases.
CO.5 – Explain nucleotide metabolism and associated diseases.
CO.6 – Summarize about the possible correlation between all metabolic pathways.

Unit	Topic/Sub-Topic	Contact Hours
1	**Glycolysis and gluconeogenesis:** Nature of metabolism. Role of oxidation and reduction and coupling of these. ATP as energycurrency. Glycolysis a universal pathway, fructose and galactose oxidation, anaerobic glycolysis, fermentation, gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis. Pentose phosphate pathway, importance of various pathways and their regulation	**12**
2	**Citric acid cycle and Oxidative phosphorylation:** Pyruvate dehydrogenase complex, oxidation of acetyl CoA, amphibolic role, regulation and glyoxylate pathway. The respiratory chain in mitochondria, proton gradient powering ATP synthesis, glycerol-3-phosphate and malate-aspartate shuttle, regulation of oxidative phosphorylation.	**12**
3	**Glycogen metabolism:** Glycogenolysis, phosphorylase regulation, role of epinephrine and glucagon for glycogenolysis, glycogenesis; reciprocal regulation of glycogenesis and glycogenolysis. Diseases associated with the abnormal carbohydrate metabolism.	8
4	**Fatty acid and amino acid degradation:** TAG as energy source, β oxidation of fatty acids in mitochondria and peroxisomes, ketone bodies. Fatty acids activation, regulation of fatty acid oxidation, Protein degradation to amino acids, Role of essential and non-essential amino acids in growth and development. Protein calorie malnutrition - Kwashiorkar and Marasmus, urea cycle, feeder pathways into TCA cycle. Nitrogen fixation. Diseases associated with the abnormal metabolism.	**12**
5	Nucleotide Metabolism: Biosynthesis - de novo and salvage pathways, regulation of nucleotide synthesis by feedback inhibition, degradation and excretion. Diseases associated with the abnormal metabolism	10
6	**Integration of metabolism:** Brief role of hormones - insulin, glucagon; metabolic shifts to provide fuel to brain during fasting and starvation, Increase in gluconeogenesis and muscle protein breakdown.	6

GE-5: Intermediary Metabolism (PRACTICAL)

SEMESTER –III

PRACTICAL	Subject Code: BSBCP305GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate assay for various clinically important carbohydrates.

CO. 2- Demonstrate fermentation for various parameters.

CO. 3- Demonstrate serum test for various parameters in different microorganisms.

CO. 4- Practice clinical test by various proteins in biological samples.

CO. 5- Employ assays for various enzymes' in different samples.

CO. 6- Demonstrate serum creatinine test for various samples.

S.No.	List of Experiments	Contact Hours
1	Estimation of glucose	4
2	Alcohol fermentation by yeast	4
3	H2S production, indole production and ammonia production by bacteria.	6
4	Urea estimation.	6
5	Uric acid estimation.	5
6	Estimation of creatinine	5

Recommended Books:

- Biochemistry: Campbell, M.K. & Farrel, S.O. Brooks/Cole, Cengage Learning (Boston),7th Ed. 2012.
- Biochemistry: Berg, J.M., Tymoczko, J.L. & Stryer L., W.H., Freeman and Company (New York), 7th Ed. 2012.

GE-6: Recombinant DNA Technology

SEMESTER- III

THEORY	Subject Code: BSBCT306GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits- 4

Course Objective: The objective of the course is to teach:

1 Basics of theory and practical aspects of recombinant DNA technology

2. Various techniques for DNA manipulation in prokaryotes and eukaryotes

3. Applications of this knowledge for the development of diagnostics, therapeutics, vaccines, etc.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe Basics of theory and practical aspects of recombinant DNA technology.

CO.2 – Define cloning vectors for prokaryotes and eukaryotes and their applications.

CO.3 – Explain transformation, selection for transformed cells and identification of recombinants.

CO.4 – Discuss polymerase chain reaction and DNA sequencing and expression of cloned genes.

CO.5 – Summarize genetic engineering as well as genetically modified crops and ethics concerns.

Unit	Topic/ Sub Topic	Contact hours
1	**Introduction to recombinant DNA technology:** Overview of gene cloning. Restriction, modification systems and DNA modifying enzymes,DNA analysis by electrophoresis.	8
2	**Cloning vectors for prokaryotes and eukaryotes:** Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors for *E. coli* like pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage.Ti plasmid,BAC and YAC.	12
3	**Introduction of DNA into cells and selection of recombinants:**Ligation of DNA molecules. Introduction of DNA into cells, Transformation, selection for transformed cells. Identification of recombinants, blue-white selection. Identification of recombinant phages. cDNA and Genomic libraries	12
4	**Polymerase chain reaction and DNA sequencing:** Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by Sanger's method and automated DNA sequencing. **Expression of cloned genes:** Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant p	16
5	**Applications of genetic engineering in biotechnology:** Production of recombinant proteins such as insulin and factor VIII. Gene therapy. Genetically modified herbicide glyphosate resistant crops. Ethics concerns.	12

GE-6: Recombinant DNA Technology (PRACTICALS)

SEMESTER- III

Practical	Subject Code: BSBCP306GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits- 2

Course Objective: This module is a general introduction to the Applications of this knowledge for the development of Diagnostics, Therapeutics, Vaccines, etc.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate assay for nucleic acid by various methods.

CO. 2- Demonstrate isolation process of plasmid DNA from different microorganism.

CO. 3- Apply restriction digestion reaction in different isolated compounds.

CO. 4- Illustrate PCR techniques.

CO. 5- Illustrate DNA insertion techniques by cloning.
CO. 6- Demonstrate gel electropherograms for various samples.
CO. 7- Demonstrate designing of primers for various nucleic acids.

S.No.	List of Experiments	Contact hours
1	DNA estimation by UV spectrophotometry	4
2	Isolation of plasmid DNA from *E. coli*.	4
3	Restriction digestion and agarose gel electrophoresis.	4
4	Amplification of a DNA fragment by PCR.	6
5	Cloning of DNA insert	4
6	Interpretation of sequencing gel electropherograms	4
7	Designing of primers for DNA amplification	4

Recommended Books:

- Gene Cloning and DNA Analysis: Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK), 6th Ed. 2010.
- Molecular Biotechnology: Principles and Applications of Recombinant DNA: Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), 4th Ed. 2010.

GE7- Biochemical Correlation in Diseases
SEMESTER-IV

THEORY	Subject Code: BSBCT407GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of Enzymes and their functions. The module also gives insight to importance of Enzymes.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1 – Describe the disorders of carbohydrates.
CO.2 – Memorize the disorders of lipids and lipoprotein metabolism.
CO.3 – Discuss the inborn errors of amino acid metabolism.
CO.4 – Explain the enzymes of liver, cardiac and skeletal muscle and disorders of purine and pyrimidine.
CO.5 – Define osteomalacia, osteoporosis, hyper and hypocalcemia, water and fat-soluble vitamins.

Unit	Topic/ Sub Topic	Contact hours
1	Carbohydrates and its disordes: Diabetes: types, Laboratory diagnosis. Diabetic ketoacidosis. Other metabolic complications of diabetes mellitus, treatment. Hypoglycemia. Inborn errors of carbohydrate metabolism - disorders of galactose, fructose, lactose and pentose metabolism. Glycogen storage disorders.	12
2	Lipids and its disorders: Disorders of lipids and lipoprotein metabolism, Metabolic adaptations in starvation and obesity. Metabolic syndrome. Laboratory diagnosis of these disorders. Association with atherosclerosis and the consequences. Biochemical derangements in metabolic syndrome.	12
3	Proteins: Plasma proteins in health and disease. Proteins in other body fluids (urine, cerebrospinal fluid, amniotic fluid, saliva and faeces). Amino acids: Inborn errors of amino acid metabolism, Aminoacidurias and their diagnosis. Disorders of amino acid metabolism and their laboratory diagnosis.	12

4	Enzymology: Enzymes of liver, cardiac and skeletal muscle. Laboratory diagnosis of myocardial infarction. Pancreatic enzymes. LDH, SGOT/SGPT Nucleic acids: Disorders associated with abnormalities in the metabolism of purines & pyrimidines.	12
5	MineraI and bone metabolism: Laboratory assessment of rickets, osteomalacia, osteoporosis. Markers for osteoblasts and osteoclasts. Hyper and hypocalcemia, Disorders of magnesium. Vitamins: water soluble and fat-soluble vitamins, Megavitamin therapy, Hypervitaminosis. Antivitamins and vitamin analogues, Use of vitamins in therapy.	12

GE-7: Biochemical Correlations in Diseases (PRACTICALS)

SEMESTER- IV

Practical	Subject Code: BSBCP407GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30,Credits- 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Demonstrate assay for lipid profile by various methods.

CO. 2- Demonstrate anthrompometric measurements in various samples.

CO. 3- Illustrate blood proteins in animals by various accepted methods.

CO. 4- Practice measurement of blood pressure by various techniques.

CO. 5- Illustrate inorganic ions presence in biological samples.

S.No.	Topic/ Sub Topic	Contact hours
1	Lipid Profile: Triglyceride, Cholesterol	5
2	Anthrompometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA)	10
3	Haemoglobin Estimation	5
4	Blood pressure measurement	5
5	Calcium Estimation	5

Recommended Books:

- Biochemistry With Clinical Concepts and Case Studies: Satyanarayana, U; Chakrapani, U, Elsevier India PVT LTD, 4th Ed. 2016.
- Pharmaceutical Chemistry: Chatwal, G. R. & Arora, M., Himalaya Publishing House Mum. 5th. Ed. 2017.
- Textbook of Medical Biochemistry: Chatterjea, M. N. & Rana Shinde, Jaypee Brothers, New Delhi, 7th Ed. 2007.

SC -1: Biochemical Techniques

SEMESTER-III

THEORY	Subject Code: BSBCT301SC
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits- 4

Course Objective: This module introduces experimental techniques used in biochemistry and these include methods of protein purification and analyzing biomolecules.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1- Describe various separation techniques for different molecules present in the cell.

CO. 2- Discuss the theoretical principles of various separation techniques in chromatography and typical applications of chromatographic techniques.

CO. 3- Define an adequate knowledge of the principles, instrumentation and applications of electrophoresis.

CO. 4- Explain and understand the basic instrumentation of Centrifugation and radioisotope techniques for separation, identification and characterization of compounds.

CO. 5- Explain the theoretical principles of selected instrumental methods within electroanalytical, spectrometric/spectrophotometric methods.

Unit	Topic/Sub-Topic	Contact hours
1	Separation techniques: Different methods of protein precipitation: Precipitation using inorganic salts (salting out) and organic solvents, isoelectric precipitation, Dialysis, Ultrafilteration, Lyophilization	10
2	Chromatography: Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparative and analytical applications, LPLC and HPLC, Different types of chromatography: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Liquid Chromatography	14
3	Electrophoresis: Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, Isoelectric Focusing of proteins.	12
4	Centrifugation: Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)	12
5	Spectrophotometry: Principle of UV-Visible absorption spectrophotometry, instrumentation and applications Fluorimetry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, instrumentation and applications	12

Recommended Books:

- Principles and Techniques of Biochemistry & Molecular Biology: Wilson K and Walker J, Cambridge University Press, 7th Ed. 2010.
- Cell and Molecular Biology: Concepts & Experiments: Karp G, John Wiley &Sons.Inc. , 6th Ed. 2010.
- Cell and Molecular Biology: De Robertis & De Robertis, Wolters Kluwer Pvt. Ltd. (India) 8th Ed. 2010.

SC-2: Principles of Drug Discovery

SEMESTER III

THEORY	Subject Code: BSBCT302SC
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits- 4

Course Objective: The subject imparts basic knowledge of drug discovery process. This information will make the student Competent in drug discovery process.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe basics of drug discovery and pharmacokinetics and pharmacodynamics properties in drug design.
CO.2 – Define biological pathways for their potential as drug targets for a given disease.
CO.3 – Explain in silico lead discovery techniques and assay development for hit identification of drug.
CO.4 – Discuss docking based screening and De novo drug design.
CO.5 – Summarize QSAR Statistical methods.

Unit	Topic/ Sub Topic	Contact hours
1	History of drug discovery: Drug Discovery from Natural Products. Pharmacokinetics and Pharmacodynamics in Drug Design. Molecular Modelling and Drug Design. Receptors and Drug Action. Physicochemical and Biopharmaceutical Properties of Drug.	10

2	An overview of modern drug discovery process: Target identification, target validation, lead identification, and lead Optimization. Economics of drug discovery. Target Discovery and validation Role of Genomics, Proteomics and Bioinformatics. Role of Nucleic acid microarrays, Protein microarrays, Antisense technologies, siRNAs, antisense oligonucleotides, Zinc finger proteins. Role of transgenic animals in target validation.	12
3	Lead Identification: combinatorial chemistry & high throughput screening, in silico lead discovery techniques; Assay development for hit identification. Protein structure Levels of protein structure, Domains, motifs, and folds in protein structure. Computational prediction of protein structure: Threading and homology modeling methods. Application of NMR and X-ray crystallography in protein structure prediction.	14
4	Molecular docking**:** Rigid docking, flexible docking, manual docking; Docking based screening. De novo drug design. Quantitative analysis of Structure Activity Relationship History and development of QSAR, SAR versus QSAR, Physicochemical parameters, Hansch analysis, Fee Wilson analysis, and relationship between them.	12
5	QSAR Statistical methods: regression analysis, partial least square analysis (PLS) and other multivariate statistical methods. 3D-QSAR approaches like COMFA and COMSIA Prodrug design Basic concept, Prodrugs to improve patient acceptability, Drug solubility, Drug absorption, and distribution, site specific drug delivery and sustained drug action. Rationale of prodrug design and practical consideration of prodrug design.	12

Recommended Books:

- Drug Design: Basic & Apllication: Mukesh Doble, Tata McGraw Hill Education Private Limited, 2011.
- Basic Principles of Drug Discovery and Development: Benjamin E. Blass, Elsevier, 1st Ed. 2015.

SC 3-Medical & Microbial Techniques

SEMESTER- IV

THEORY	Subject Code: BSBCT403SC
Total Marks for Evaluation:50	No. of Contact Hours: 60, Credits: 4

Course Objective:

1. To impart basic understanding of microbial techniques by hands on experience on working with microorganisms. 2. To teach students about various control methods for the growth of microbes. 3. To make students aware about the characteristic features of different microbes.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe Culture media and various culture techniques.

CO. 2 – Define control of microorganisms by physical and chemical methods

CO.3 – Explain various mechanism of staining of microorganism.

CO.4 – Discuss importance, isolation and cultivation of viruses.

CO.5 – Classify various diagnosis methods for infectious and non infectious diseases.

Unit	Topic/Sub-Topic	Contact hours
1.	Microbial Nutrition and Growth: The common nutrient requirements. Nutritional types of microorganisms. Culture media and its components, Synthetic or defined media, Complex media, Enriched media, Selective media, Differential media. Isolation of Pure culture: Streaking, Serial dilution and Plating methods, cultivation, maintenance of pure cultures. Microbial Growth: phases of growth, measurement of microbial growth	8

2	Control of microorganisms by physical and chemical methods: Mechanism of Dry Heat, Moist Heat, Hot air oven, Filtration and Radiations, Use of Phenolics, alcoholics, halogens, heavy metals, aldehydes and gases for sterilization.	16
3	Bacterial, Fungal and Algal cell organization and staining: Overview of characteristic features of bacterial, fungal and algal cell. Composition and detailed structure of gram- positive and gram-negative cell wall. Simple staining and negative staining of bacteria. Mechanism of gram staining.	12
4	Introduction to Viruses: General characteristic features of viruses. Nacked and envelop viruses. Examples of RNA and DNA viruses. Subviral particles: viroids, prions, virusoids and their importance. Isolation and cultivation of viruses. Virus purification and assays	16
5	Immunoserology: Principles and Application I: Antigen-antibody interaction and its use in diagnosis: Detection and diagnosis of common infectious diseases: Widal and typhi dot for typhoid, Malaria antigen in Malaria, NS1 antigen in Dengue Principles and Application II: For common non infectious diseases: Acylatedhaemoglobin in Diabetes, TSH levels in Thyroid condition.	8

Recommended Books:

- Prescott's Microbiology. Willey J. M., Sherwood L. M. & Woolverton C. J., McGraw Hill Higher Education., 10th Ed. 2017.

SC 4- Bioinformatics

SEMESTER IV

THEORY	Subject Code: BSBCT404SC
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objectives: The aim of this module to provide practical training in bioinformatics including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1 – Describe various resources or tools available for bioinformatics.
CO. 2 – Define sequence similarity and alignment using the bioinformatic tools.
CO. 3– Discuss sequence alignment for various molecules.
CO. 4 – Explain phylogenetic analysis.
CO. 5 – Predict protein structure by using different database.

Unit	Topic/Sub-Topic	Contact hours
I.	Bioinformatics: Definition, history of bioinformatics, Basic terminology used, Applications of Bioinformatics, introduction to NCBI, basic tools of NCBI, database searching and database retrieving from NCBI, Human Genome project.	12
2	Biological Data bases: Definition, types of database, overview of primary and secondary database, Nucleic acid sequence, data bases (NCBI, EMBL and DDJB), Protein sequence data base-SWISS-PORT, database searching: BLAST and FASTA.	12
3	Sequence alignment: Local and global Alignments, pair wise alignment, substitution scoring and gap penalties, Statistical significance of alignment, multiple sequences alignment: progressive alignment methods, motife and patterns,	12
4	Phylogenetic analysis : Element of phylogenetic model, data analysis, tree building and tree evaluation, building methods, searching for a tree, phylogenetic software, CLUSTAL, PHYLIP & UPGMA. Gene finding and gene scan.	12
5	Protein structure prediction : Physical properties, secondary structure, alpha & beta structure, motifs, tertiary structures, specialized structure and function, protein conformation and visualization tool- RASMOL, role of bioinformatics in drug discovery, docking and prediction of drug quality.	12

Recommended Books:

- Introduction to Bioinformatics: Attawood T., Parruy-Smith D. J. & Samiron Phukan, Pearson Education.4th Ed. 2009.
- Bioinformatics: Managing Scientific Data: Zoe' Lacroix & Terence Critchlow, Elsevier Science, 2003.
- Bioinformatics: Sequence, Structure and Databanks: Des Higgins & Willie Taylor, 2000.
- Structural Bioinformatics: Philip E. Bourne, Helge Weissig, John Wiley & Sons, Inc, 2003.

SC -2 Herbal Technology
SEMESTER IV

THEORY	Subject Code: BSBCT405SC
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits- 4

Course Objective: The subject imparts basic knowledge of drug discovery process. This information will make the student Competent in drug discovery process.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1 – Describe basic principles of traditional medicinal systems with method of preparation and standardization of ayurvedic formulations.

CO.2 – Define rules and regulation for assessment of herbal drugs, herbal formulations based on traditional medicinal system.

CO.3 – Explain characteristics, chemical constitution, and method of isolation and estimation of herbs used for haircare.

CO.4 – Apply present status of herbal drug based industry and components for good manufacturing practice for Indian systems of medicine

Unit	Topic/ Sub Topic	Contact hours
1	Cosmetics preparations: Incorporating the herbal extracts in various cosmeticformulations like Skin care preparations (Creams and Lotions), Sunscreens andSunburn applications, Hair care preparations (Hair oils and Hair shampoos) andBeautifying preparations(Lipsticks, Face powders and Nail polish). Skin care herbs : a. Lipids: Appricot, Ranolin, Beesay, Olive oil, Seasome oil(Cleansing & emollent) b. Glycosides: Almond Aloe, Ambiholds, Rhubers, (Emollent &Skin Pigmentation) c. Alkaloids: Black peper, Vinca, Cinchona, Withania,(Antipimples, Antiallulite) d. Volatile oils: Chandan Khus, Saffron, Cinnamon, (Fresshers,Pigmentations & perfumes) e. Tannins: Amla, Netmeg, Tannic acid, Ashoka , Hirda,(Astrigents, Antibacterial) f. Carbohydrades: Accacia, Agar, Tragacanth, Pectin Sland(Bindes, Golmorner, Emulgents)	15
2	Standardization of herbs: Importance of standardization (asper WHO guidelines), assessment of Herbal extracts & informulations, methods employed for standardization of herbswith special reformes to industrial methods HPLC, HPTLC; Flashchromatography, GLC etc. Aromatherapy:Various Oils used in Aromatherapy with theirSignificance & skin texture.	15
3	Nomenclature, characteristics & classification, chemicalconstitution, method of isolation & estimation of herbs used for haircare. Hair grooming :- Apricot, Aloe Hair growth promoter: Brahmi, Manjistha, Jatamansi. Hair Tonics:Bawachi, Hibuscus, Amla , Almond oil, Coconut oilOlive oil. Antidandraff : Tulsi, Neem, Wheat Gram Oil, Beturla Pedula. Hair Colorants: Amala, Heena, Bhringaraja (Eclipta alba), Comomite, Safflower (Carthamus Officinatis). Hair cleansing: Ritha, Shikakai, Amla.	15

4	Fruits & vegetables as hair & skin care : Apple, Apricot, Banona, Barli, Melon, Carrot, Cucumber, honey, lemon, peach, pudina, tomato,Yogurt, tea. Extraction & isolation of active principles of herbs & theirincorporation in various cosmetics formulations like creams, lotions, powders & other cosmetics, formulations. Production trade & market for culinary herbs. Analysis of herbs : General method of analysis of herbs – Determination of standard values, qualitative & quantitative estimation of resin &sugars. Chromatographic techniques used in analysis of herbs &their constituents.	15

Recommended Books:

- Novel Cosmetic Drug Delivery Systems: Magdassi and Touitou. Marcel Dekker, 1st Ed.1999.
- Perfumes, Cosmetics and Soaps: William Poucher. Lulu. com, 2019.

AC-1A: English
SEMESTER –I/II

THEORY	Subject Code: BSBCT101AAC/BSBCT201AAC
Total Marks for Evaluation:50	No. of Contact Hours: 60, Credits: 4

Course Objective: To enable the students of management to speak and write with a fair degree of grammatical correctness.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Apply tenses during their communication and writing.
CO.2- Apply clauses for better communication.
CO.3- Apply structural items to sentences.
CO.4- Apply knowledge of reported speech for better communication skills.
CO.5- Demonstrate writing kills in English.

Unit	Topic/ Sub Topic	Contact hours
1	Tense: Simple Present, Progressive and Present Perfect, Simple Past, Progressive and Past Perfect, Indication of Futurity. Modals: will, shall, should, would, ought to, and others, Verb Structures: Infinitives, Gerund and Participles. Linking Devices, Parts of speech.	12
2	Clauses: Co-ordinate Clause- with, but, either-or, neither-nor, otherwise, or else, Subordinate Clauses: Noun Clause- as subject, object and complement, Relative Clause: Restrictive and Non-Restrictive, Adverb Clauses: open a hypothetical conditionals, ((with because, though where, so that, as long as, as soon as) Comparative Clauses.	12
3	Structural Items: Simple, Compound and Complex Sentence.	12
4	Reported Speech: Declarative Sentences, Imperative Sentences, Interrogatives (wh-questions, yes/no questions, Exclamatory Sentences. Voice: Transformation of Sentences from Active to Passive and visa-versa.	12
5	Composition: Paragraph Writing, Essay and Letter Writing	12

Recommended Book:

- English Grammer in Use: R. Murphy, Cambridgre University Publication, 4th Ed. 2012.
- English Made Easy: Chetanan & Singh, BSC Publishers & Distributors, 2nd Ed. 2018.

AC-2: Environmental Sciences

SEMESTER –I/II

THEORY	Subject Code: BSBCT102AC/BSBCT202AC
Total Marks for Evaluation:50	No. of Contact Hours: 60, Credits: 4

Course Objective: This module will inform the students about the facts of the Environment, its importance and about its protection.

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1 – Describe natural resources, food resources, land resources and energy resources.

CO. 2 – Classify various biodiversity and its conservation.

CO.3 – Explain different types of pollution, their causes, effects and control measures.

CO.4 – Discuss environmental issues, pollution, ethics, water conservation and global warming.

Unit	Topic/Sub-Topic	Contact hours
1.	Natural Resources: Renewable and Non-renewable Resources Forest, Water and Mineral resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forests and tribal people and relevant forest Act. Use and over-utilization of surface and ground water, floods drought, conflicts over water, dam's benefits and problems and relevant Act. Use and exploitation, environmental effects of extracting and using mineral resources. Food resources and energy resources food, Energy and Land resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging , salinity. Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land as a resource, land degradation, man induced landslides soil erosion and desertification.	18
2	Biodiversity and its Conservation Introduction- Definition: genetic. species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: Consumptive use. productive use, social ethics, aesthetic and option values, Biodiversity at global, National and local levels, India as mega-diversity nation, Hot spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wild life, conflict,dangered and endemic species of India, Conservation of biodiversity: In situ and Ex-situ conservation of biodiversity.	16
3	Causes, effect and control measures of Air water, soil, marine, noise, nuclear pollution and Human population, Solid waste management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Disaster Management: floods, earthquake, cyclone and landslides.	12

4	Social issues an environment: From Unsustainable to Sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Environmental ethics: Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. • Wasteland reclamation., • Consumerism and waste products., • Environment Protection Act. • Air (Prevention and Control of Pollution) Act., • Water (Prevention and control of Pollution) Act, • Wildlife Protection Act. • Forest Conservation Act, • Issues involved in enforcement of environmental legislation., • Public awareness	14

Recommended Books:

- Textbook for environmental studies for undergraduate courses of all branches of higher education: Erach Bharucha, University PRESS.

EC-1: Seminar

SEMESTER – III/IV/V/VI

Name of the Programme/Semester: B.Sc BC/ Sem-III/IV/V/VI	Subject Code: BSBCTSE01EC

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1-Practice scientific readings & presentation skills.

CO. 2- Outline how to make a poster for seminar and conferences.

CO. 3- Practice persuasive speech, present information in a compelling, well-structured, and logical sequence.

CO. 4- Express oral and written communication skills.

EC-2: MOOC

SEMESTER – IV/V/VI

Name of the Programme/Semester: B.Sc BC/ Sem-IV/V/VI	Subject Code: BSBCMO01EC

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO. 1- Show the ability to strictly follow the course information.

CO. 2- Develop participation and engagement by creating learner-centered communities using group projects.

CO. 3- Solve the weekly assignments and assessments given based on critical thinking.

CO. 4- Develop time management, intrinsic motivation and commitment to the course.

CO. 5- Develop self-directed learning environment and enhancement of computer and language.

EC-3: Summer Internship

SEMESTER –VI

Name of the Programme/Semester: B.Sc BC/ Sem- VI	Subject Code: BSBCSI401EC

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:

CO.1- Practice the latest techniques in research and development laboratories.

CO. 2- Apply the working principles of basic and high throughput instruments.

CO.3- Practice persuasive speech, present information in a compelling, well-structured, and logical sequence.

CO. 4- Demonstrate hands on practical skills.