BIOSTATISTICS AND BIOMODELING [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15BT41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to

- Appreciate the wide range of utilities of statistics and probability to Biological data
- Apply the concepts related to curve fitting, correlation coefficient, regression analysis etc., to specific cases.
- Learn the concepts of basic probability and random variables, while deciphering the applications of distributions and stochastic process for defined cases.
- Study the importance of modeling and simulations for biological problems.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE – 1		
BASIC STATISTICS Histogram, Ogive curve, Pie Diagram. Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation), Skewness & kurtosis**.**	**10 Hours**	**L1, L2**
MODULE –2		
BI-VARIATE DISTRIBUTION Correlation, rank correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential).	**10 Hours**	**L1, L2**
MODULE – 3		
PROBABILITY Axioms, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multi-locus/ allele finger print systems. Random variables- Discrete and Continuous Probability distribution, Mathematical expectations	**10 Hours**	**L1, L2, L3**
MODULE – 4		
PROBABILITY DISTRIBUTIONS Discrete probability distributions- Binomial, Poisson, normal, exponential derivations. Central limit theorem. T distributions.	**10 Hours**	**L1, L2, L3, L4**
MODULE – 5		

STATISTICAL INFERENCE Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, parametric and non-parametric distributions -F-test, Chi Squared distribution, and goodness of fit test analysis of variance (one-way classifications). Randomization, random assignments, single and double blind experiments. Case studies of statistical designs of biological experiments. Microbial Growth in a Chemostat, Growth Equations of Microbial populations, Models of Commensalisms, Mutualism, Predation and Mutation. Volterra's Model for n Interacting Species. Cigarette smoking, Lung cancer, epidemics.	**10 Hours**	**L2, L3**

Course outcomes: After studying this course, students will be able to:

- Fit a suitable curve for the tabulated data by the method of least squares, find correlation coefficients and analyze.
- Apply different types of tests to test the hypothesis relating to small samples.
- Appreciate the concepts of probability, distributions and various stochastic process.
- Perform modeling and simulations experiments for select biological processes using appropriate data.

Graduate Attributes (as per NBA):

- Computational Knowledge.
- Problem Analysis.
- Design / development of solutions.
- Modern tool usage.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Biostatistics by Marcello Pagano & Kimberlee G, Thompson Learning.
2. Introduction to Biostatistics by Ronadd N Forthofer and EunSul Lee, Academic Press.
3. Mathematical Models in Biology and Medicine by J.N.Kapur New Age International.
4. Introduction to Biostatistics by Ipsen, Feigl & Bancroft, Harper & Row, Publishers,NY.
5. Basic Biostatistics & its Applications by Animesh K Datta , New Central Book Agency.
6. Fundamentals of Biostatistics by P Hanumanth Rao and K Janardhan, IK Intl. Publishers.
7. Biostatistics by Rastogi V.B. Medtec 3rded , 2015

Reference Books:

1. Statistical methods in Bioinformatics by Warren J. Ewens, Gregory R. Grant, Springer 2nd edition, 2006.
2. An Introduction to Biostatistics by P. S. S. Sundar Rao and J. Richard, Prentice Hall of India, publications, 4th edition, 2006.
3. Biostatistics: A foundation for Analysis in the Health sciences by Wayne W. Daniel, John 7th edition, 2000.
4. Fundamentals of Biostatistics by Veer BalaRastogi, Ane Books India.

BIOCHEMICAL THERMODYNAMICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15BT42	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to

- To know the basic concepts of thermodynamics in process industry.
- To understand the significance of zeroth, I, II & III laws of thermodynamics.
- To be aware of concepts of thermodynamic properties of fluids & demonstrate various equations of state & their applications.
- To illustrate the importance of partial molar properties & the concepts of phase equilibrium.
- To illustrate the concepts of chemical reaction equilibrium.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE – 1		
BASIC CONCEPTS & LAWS OF THERMODYNAMICS System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state, enthalpy, specific heat, Reversible and Irreversible processes. Zeroth law of Thermodynamics, General statement of First law of Thermodynamics, First law for Cyclic Process, Non-Flow Process, Flow process, Heat capacity. Heat reservoir and Heat engines. General statements of the second law, Concept of entropy, Carnot principle, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility, Third law of Thermodynamics. Numericals	**10 Hours**	**L1, L2**
MODULE –2		
PVT BEHAVIOUR AND COMPRESSIBILITY CHARTS PVT Behavior of pure fluids, equations of state & ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic & polytrophic processes, Equations of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, virial equation. Numericals. Principles of corresponding states, generalized compressibility charts, Heat effects accompanying chemical reactions, Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction.	**10 Hours**	**L2, L4**

Numericals.		
MODULE – 3		
PROPERTIES OF PURE FLUIDS & THERMODYNAMIC DIAGRAMS Reference properties, energy properties, derived properties, work function, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). Gibbs- Helmholtz equation. Concept of Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, solids and liquids, Activity: Effect of temperature and pressure on activity. Numericals. Thermodynamic diagrams – types of diagrams and construction of thermodynamic diagrams. Numericals.	**10 Hours**	**L2, L3,L4**
MODULE – 4		
PROPERTIES OF SOLUTIONS & PHASE EQUILIBRIA Partial molar properties of solution and its determination , chemical potential –effect of temperature and pressure , lewis –randall rule, Raoults law for ideal solutions, fugacity in solutions, Henry's law and dilute solutions – ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients – effect of temperature and pressure, Gibbs - Duhem equation, calculation of activity coefficients using Gibbs-Duhem equation. Numericals. Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, Consistency test for VLE data, Azeotropes. Numericals.	**10 Hours**	**L2, L3**
MODULE – 5		
BIOCHEMICAL ENERGETICS Coupled reactions and energy rise compounds, Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature, pressure on equilibrium constants and other-factors affecting equilibrium conversion – Le – chatelier's principle, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems, Liquid-Liquid Equilibrium diagrams. Numericals.	**10 Hours**	**L2**
Course outcomes: After studying this course, students will be able to: • State & describe the concepts of system, surrounding, process, laws of thermodynamics & entropy. • Explain the PVT behavior of pure fluids & gases & derive equations of state for real		

gases.
- Distinguish between work function, gibbs free energy & analyze the thermodynamic diagrams.
- Determine the partial molar properties , activity coefficients of the solution.
- Illustrate the phase rule for reacting systems and effect of temperature, pressure on equilibrium constants.

Graduate Attributes (as per NBA):
- Engineering Knowledge
- Problem Analysis
- Design/development of solutions

Question paper pattern:
- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Introduction to Chemical Engineering thermodynamics, 6th Ed (2003) by J.M. Smith , H.C. Van Ness & M.M.Abbott. MGH.
2. Biochemical Calculations, 2nd Ed,(1976) by Irwin H.Segel, John Wiley & Sons.
3. Engineering Thermodynamics by R K Singal, I K Intl.
4. Engineering Thermodynamics by Spading and Cole, ELBS.
5. Engineering Thermodynamics by Jones J.B. Hawkins, John Wiley.
6. Principles of Biochemistry by Albert Lehninger, CBS publishers.
7. Bioenergetics by L Eruster, Academic Press, New York

Reference Books:

1. Chemical Engineering Thermodynamics by Y.V.C. Rao, New Age International.
2. A Textbook of Chemical Engineering Thermodynamics, 1st Ed (2001) by K.V. Narayanan, PHI.
3. Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition.
4. Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.
5. Biochemistry by Garett & Grisham, Thompson Learning.

MOLECULAR BIOLOGY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15BT43	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- The underlying concepts of Central Dogma and learn the mechanism of replication of DNA, Transcription of a gene and Translation of mRNA.
- Gene expression in a prokaryotic and eukaryotic cell.
- The importance of genetic recombination, damage and repair.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE – 1		
INTRODUCTION & REPLICATION OF DNA Chromosomal theory of heredity, genes and their location. Genetic code, Information flow in biological systems: central dogma, updated central dogma. Structures and forms of nucleic acids – DNA and RNA. Replication of DNA, structure and function of DNA polymerases, models of replications in prokaryotes, mechanism of DNA replication and enzymes involved.	**10 Hours**	**L1, L2,L3**
MODULE –2		
TRANSCRIPTION: Structure and function of RNA polymerases (prokaryotes & eukaryotes), mechanism of transcription in prokaryotes and eukaryotes, transcription factors, post-transcriptional processing (RNA editing, siRNA, splicing, poly A tail and 5' capping), transcription inhibitors.	**10 Hours**	**L1, L2,L4**
MODULE – 3		
TRANSLATION Mechanism of translation, activation of amino acid initiation, elongation and termination of protein synthesis. Post translational modification and protein targeting, protein splicing. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.	**10 Hours**	**L1, L2, L3**
MODULE – 4		
GENE EXPRESSION IN PROKARYOTES & EUKARYOTES Regulation of gene expression in prokaryotes: Operon	**10 Hours**	**L1, L2, L3, L4**

model, gal, lac, trp Operons; positive versus negative regulation. Regulation of eukaryotic gene expression, transcriptional control, homeobox in the control of developments in insects and vertebrates.		
MODULE – 5		
GENETIC RECOMBINATION, MUTATION & GENE MAPPING Genetic recombination in bacteria and viruses, site specific recombination, transposons and insertion sequences; Retroviruses. DNA damage & Repair, Mutation, Role of recombination and transposition in evolution; gene mapping techniques.	**10 Hours**	**L2, L3**

Course outcomes:

After studying this course, students will be able to:

- Explain replication, transcription and translation processes with underlying differences in prokaryotic and eukaryotic systems.
- Elaborate importance of genetic recombination with special reference to bacterial system.
- Outline DNA damage and repair mechanisms

Graduate Attributes (as per NBA):

- Modern tool usage.
- Lifelong learning.
- Problem analysis

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Essentials of Molecular Biology by David Freifelder, Narosa Pub. House.
2. Molecular Biology of the Cell by Alberts et al., Garland Publishing.
3. Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.
4. Molecular Biology of the Gene by James D Watson et al., Pearson Education.

Reference Books:

1. Statistical methods in Bioinformatics by Warren J. Ewens, Gregory R. Grant, Springer 2nd edition, 2006.
2. An Introduction to Biostatistics by P. S. S. Sundar Rao and J. Richard, Prentice Hall of India, publications, 4th edition, 2006.
3. Biostatistics: A foundation for Analysis in the Health sciences by Wayne W. Daniel, John 7th edition, 2000.
4. A Textbook of Molecular Biology by S.M Gopinath, Archers & Elevators International Publishing House India. 1st Edition. 2014.
5. Fundamentals of Biostatistics by Veer BalaRastogi, Ane Books India.

BIOPROCESS PRINCIPLES & CALCULATIONS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BT44	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Learn fundamentals of chemical calculations and material and energy balance.
- Discuss the material balance aspects involving chemical reactions and without chemical reactions.
- Highlight the energy balance and material balance for the development of bioprocess technology.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE – 1		
BASIC CHEMICAL CALCULATIONS AND MATERIAL BALANCE Concept of atom and mole, expressing composition of mixtures in Solids, liquids and gases. Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Morality, Molality. Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing, drying & evaporation	**10 Hours**	**L1, L2,L3**
MODULE –2		
MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS AND FUELS Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels, characteristics of fuels, Ultimate and proximate analyses of fuels.	**10 Hours**	**L1, L2,L3**
MODULE – 3		
MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS Material balances calculation involving bypass, recycle and operations. Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, unit process – neutralization, oxidation, nitration, hydrolysis, and problems relating to these unit processes.	**10 Hours**	**L1, L2, L3,L4**
MODULE – 4		
ENERGY BALANCE General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of	**10 Hours**	**L1, L2, L3, L4**

reaction, Standard heat of combustion and calorific value, Calculation of heat of reaction at elevated temperature.		
MODULE – 5		
BIOPROCESS PRINCIPLES & STOICHIOMETRY OF BIOPROCES Historical development of bioprocess technology; Bioprocess principles and operations, generalized process flow sheets. General material balance equation for steady state (for manufacture of penicillin and ethanol) - outline of a bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses. Stoichiometry of microbial growth and product formation.	**10 Hours**	**L2, L3, L5**

Course outcomes:

After studying this course, students will be able to:

- Discuss the significance of material and energy balance for bioprocess technology.
- Solve problems related to material and energy balance to give solutions for bioprocess development.
- Develop the flow-sheet for general processes operating in bioprocess industry.
- Appreciate the stoichiometry of microbial growth and product formation involved in bioprocess technology

Graduate Attributes (as per NBA):

- Problem analysis
- Design / development of solutions.
- Computational knowledge.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Biochemistry by David L. Nelson (Editors), W.H. freeman and company.
2. Bioprocess Engineering Principles by Pauline Doran, Academic Press.
3. Biochemical Engg. Fundamentals by J E Bailey & D. F. Ollis, McGraw Hill.
4. Biochemical Calculations by I.H.Segel, John Wiley & Sons.

Reference Books:

1. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI
2. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
3. Chemical Process Calculations by R. Asokan, University Press, 2011.

STRUCTURAL BIOLOGY

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BT45	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Appreciate the importance of structure, scope and function of macromolecules.
- Understand the structure organization, work and function of macromolecules at molecular level.
- Know the various qualitative and quantitative physical methods available for structure elucidation.
- Learn the various interactions involved in macromolecular structure and their roles towards stability and function

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
MODULE – 1		
INTRODUCTION & PROTEIN STRUCTURE Levels of molecular organization, Brief discussions on: Amino acids, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones. Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions, vanderwaals forces, potential energy calculations, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions, Scatchard plot, cooperative interactions, allosteric effects, Hill constant; Relationship between the primary, secondary, and tertiary structure of proteins. Structure of IgG, fibrous proteins (structure of collagen, keratin). Quaternary structures - dimers, homo & hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains (qualitative examples)	**10 Hours**	**L1, L2**
MODULE –2		

STRUCTURE OF NUCLEIC ACIDS AND BIOMEMBRANES General characteristics of nucleic acid structures (A, T, G, C, U), forces and stabilizing geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions and small molecules. Ribose puckering and Tertiary structure of tRNA. Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, Signal transduction and molecular reception (qualitative).	**10 Hours**	**L1, L2**
MODULE – 3		
BIOPHYSICAL TECHNIQUES Rayleigh scattering, ultra-centrifugation, viscometry. Electron microscopy (SEM-TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, Mass spectrometry, LCMS, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials).	**10 Hours**	**L1, L2, L3,L4**
MODULE – 4		
SPECTROSCOPIC TECHNIQUES X-ray diffraction: structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy (structure determination). ORD/CD, UV, IR, Laser Raman, ESR/EPR.	**10 Hours**	**L1, L2, L3,L4**
MODULE – 5		
BIOMOLECULAR INTERACTIONS & MOLECULAR DYNAMICS Association of macromolecules, molecular conjugates, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. Molecular mechanics and dynamics (Newtonian and Monte Carlo simulations), theoretical principles and its importance towards insilico simulations, results of molecular dynamics calculations and their implications to biological function.	**10 Hours**	**L2, L3,L4,L5**
Course outcomes: After studying this course, students will be able to: • Present the foundational principles of macromolecular structure and function. • Apply diverse techniques that enable the elucidation of molecular structure, their organization, stability, associations and functionalities		
Graduate Attributes (as per NBA): • Problem Analysis. • Design / development of solutions. • Lifelong learning..		

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman.
2. Physical Biochemistry by David Freifelder, W H Freeman and Company.
3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman.
4. Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing.
5. Proteins Structure – A Practical Approach by Creighton, Oxford University Press.
6. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others, Prentice Hall.

Reference Books:

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition.
2. Foundations of Biophysics by A.L. Stanford, Academic Press.
3. Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag.
4. Principles of nucleic acid structure by Sanger, Springer Verlag.
5. Introduction to Protein Science by Arthur M Lesk, Oxford University Press.
6. Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press.
7. A Textbook of Biochemistry and Biophysics by S.M Gopinath, Archers & Elevators International Publishing House, India. 1st Edition, 2014.

CLINICAL BIOCHEMISTRY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15BT46	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Course objectives: This course will enable students to

- Learn the structure and function of metabolic pathways for carbohydrates, amino acids and lipids; their alterations in disorders.
- Gain insight into the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.

Modules	Teaching Hours	Revised Bloom's Taxonomy(RBT) Level
MODULE – 1		
DISORDERS OF CARBOHYDRATE METABOLISM Diabetes mellitus, glycohemoglobins, hypo-glycemias, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases. Physiology of lipids/lipoproteins. Lipidosis. Clinical inter-relationships of lipids (sphingolipidosis and multiple sclerosis), lipoproteins and apolipoproteins. Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders.	**10 Hours**	**L1, L2**
MODULE –2		
INBORN ERRORS OF METABOLISM a) Disorders of amino acid metabolism - Phenylalanemia, homocystinuria, tyrosinemia, MSUD, phenylketonuria, alkaptonuria, albinism and animoacidurias. b) Disorders of nucleic acid metabolism- Disorders in purine/ pyrimidine metabolism.	**10 Hours**	**L1, L2**
MODULE – 3		
DISORDERS OF ACID-BASE BALANCE AND THEIR RESPIRATORY AND RENAL MECHANISMS. Evaluation of organ function tests,Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Clinical importance of bilirubin. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.	**10 Hours**	**L1, L2, L3**

MODULE – 4		
HORMONAL DISTURBANCES Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disturbances in thyroid function. Disorders of mineral metabolism: Hypocalcaemia, hypocalcaemia, normocalcaemia, hypophosphatemia and hypophosphatemia.	**10 Hours**	**L1, L2, L3, L4**
MODULE – 5		
BIOCHEMICAL ASPECTS OF HEMATOLOGY Disorders of erythrocyte metabolism, hemoglobinopathies, thalessemias thrombosis and anemias. Laboratory tests to measure coagulation and thrombolysis. Detoxification in the body: enzymes of detoxification, polymorphism in drug metabolizing enzymes. Mechanism of drug action and channels of its excretion, Disorders of vitamins and trace elements.	**10 Hours**	**L2, L3**

Course outcomes:

After studying this course, students will be able to:

- Discuss the biochemistry and pathophysiology associated with various disorders of metabolism and inborn errors of metabolism.
- Describe the structure and function of metabolic pathways for carbohydrates, amino acids and lipids.
- Explain the medical problems associated with abnormal lipoprotein levels and therapeutic agents used to treat lipid disorders.
- Assess the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Design / development of solutions (pharmacological).
- Professional Ethics.
- Life-long learning

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Textbook of Medical Biochemistry by MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Lehninger- Principles of Biochemistry by David L. Nelson and Michael M. Cox, 5th Edition, WH Freeman and Company.
3. Medical Biochemistry (Paperback) By John W. Baynes and Marek Dominiczak. Publisher: Mosby.
4. Clinical Biochemistry: 3rd Ed By Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.

Reference Books:

1. Review of Medical Physiology (Lange Basic Science) (Paperback) By William F. Ganong. Publisher: McGraw-Hill Medical
2. Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange. 8. Clinical Biochemistry by Richard Luxton. Scion Publishing Ltd.
3. Clinical Biochemistry Paperbackby Nanda Maheshwari, 2008.
4. Appreciate the biochemical aspects of hematology.

CELL & MOLECULAR BIOLOGY LABORATORY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	15BTL47	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- To understand the cell division: Mitosis and Meiosis.
- To study the somatic cell hybridization.
- To learn isolation of DNA from various sources
- To learn agarose gel electrophoresis for separation of nucleic acids

Laboratory Experiments	**Revised Bloom's Taxonomy (RBT) Level**
1. Study of divisional stages in Mitosis.	**L2,L4,L5**
2. Study of divisional stages in Meiosis.	**L2,L3,L4**
3. Study of Polytene and Lampbrush chromosomes using permanent slides.	**L2,L3,L4**
4. Isolation and fusion of plant protoplasts.	**L5,L6**
5. Isolation of plasmid DNA from bacteria.	**L5,L6**
6. Isolation of genomic DNA (plant / microbial sources)	**L2,L3,L4**
7. Agarose gel electrophoresis and quantification of nucleic acids (colorimetric, ethidium bromide dot blot and standard DNA marker)	**L5,L6**
8. Digestion and mapping of plasmid pUC18.	**L2,L3,L4**
9. Competent cell preparations.	**L2,L3,L4**
10. Transformation and selection of recombinants.	**L5,L6**
11. Study of conjugation in *E.coli.*	**L5,L6**
12. Amplification of DNA by PCR.	**L5,L6**

Course outcomes: On the completion of this laboratory course, the students will be able:

- To be able to understand the mitotic and meiotic cell divisions;
- To be able to carry out somatic cell fusion;
- To separate DNA and run various fragments through electrophoresis.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design/Development of solutions.
- Modern tool usage

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Book:

1. Molecular Cell Biology by Darnell J Lodish& H Baltimore, Freeman Pub
2. Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press
3. Current protocols in molecular biology,edited by Frederick M. Ausubel et al., John Wiley & Sons
4. Methods in enzymology by Berger S.L. & Kimmel A.R., Vol.152, Academic Press.
5. Cellular & Biochemical Science by G. Tripathi, IK Intl.

CLINICAL BIOCHEMISTRY LABORATORY
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	15BTL48	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 02

Course objectives: This course will enable students to

- Qualitative and quantitative analyses of cellular components and processes.
- To design lab experiments, to make understand as to how problems are scientifically solved with supporting data.
- Acquire means to manage experiments independently.

Laboratory Experiments	**Revised Bloom's Taxonomy (RBT) Level**
1. pH measurements, volume / weight measurements, concentration units, sensitivity. Specificity, precision, accuracy, preparation of buffers of constant strength.	**L1,L2,L3,L4,L5**
2. Titration of amino acids with acids & bases.	**L2,L3,L4**
3. Qualitative tests for carbohydrate and lipids.	**L5,L6**
4. Qualitative tests for amino acids and proteins.	**L5,L6**
5. Estimation of blood sugar by Folin method and by O-toluene method.	**L2,L3,L4**
6. Estimation of inorganic phosphate by Fiske-Subbarao method.	**L4,L5**
7. Estimation of amino acid by ninhydrin method.	**L2,L3,L4**
8. Estimation of total cholesterol from Serum.	**L2,L3,L4**
9. Determination of Saponification value and iodine value of lipids with error analysis.	**L5,L6**
10. Determination of acetyl value of a lipid with error analysis.	**L5,L6**
11. Estimation of urea by diacetyl monooxime method with error analysis.	**L5,L6**
12. Estimation of iron from hemoglobin with error analysis.	**L2,L3,L4**

Course outcomes:
After studying this course, students will be able to:

- Know about biomolecules with special reference to physiological samples.
- Determine the levels of metallic ions, fats and oils and other biomolecules.

Graduate Attributes (as per NBA):

- Problem Analysis.
- Design / development of solutions.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Modern Experimental Biochemistry by Rodney Boyer, Pearson Education.
2. Practical Biochemistry by Cole, Cambridge University Press.
3. Practical Biochemistry by Keith Wilson, Cambridge University Press.
4. An introduction to practical biochemistry by Plummer, Tata McGraw Hill.
5. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K.Intl.
6. Lab Math by Dany Spencer Adams, IK Intl. Pub. House.
7. Lab Ref by Jaine Roskams & Linda Rodgers, IK Intl. Pub. House.
8. Manual of Practical Biochemistry for medical students, 2nd edition, University Press.
9. Practical Manual Of Biochemistry by Sharma S. Medtech ,2016