DETAILED SYLLABI OF
B.Tech DEGREE PROGRAMME IN
BIOTECHNOLOGY
III-VIII SEMESTER
(Effective from 2017 Admitted Batch Onwards)

DEPARTMENT OF BIOTECHNOLOGY
NATIONAL INSTITUTE OF TECHNOLOGY SIKKIM

SEMESTER III

BT13101 ADVANCE CHEMISTRY FOR BIOTECHNOLOGY
Prerequisite: Nil

Total Hours: 42 Hrs

L	T	P	C
3	1	0	3

Module 1 (08 h)

Chemical Kinetics - Concepts in Chemical Kinetics Elementary Reactions with Simple Rate Laws (Zero-Order Reactions, First-Order Reactions, second-Order Reactions, equilibrium), Temperature Dependence of Rate Constants, Pseudo-First Order Kinetics, Third Order Kinetics, van't Hoff and Half-Life Plots for Determining Reaction Order, Consecutive Reactions and the Steady State Approximation, Collision Theory, Activated Complex Theory (ACT) or Transition State Theory, Applications of Transition State Theory.

Module 2 (12 h)

Metals in Biology - Role of metals in biology: an overview; Choice of metals; Suboptimal choices for catalytic metals; Uptake and storage of metals in biology; Redox-active metals in enzymes; Redox inactive metals in enzymes, Reactions of small molecules; Dioxygen activation in biology by cytochrome P-450, methane monooxygenases, Rieske dioxygenases, Role o Oxygen evolving complex (OEC) in photocatalytic splitting of water; Metal ions as Lewis acids; Metals that generate organic radicals.

Module 3 (12 hours)

Introduction to Biomolecules - Introduction to cells and organelles, Structure and properties of water, Buffer, Introduction to Biomolecules, Carbohydrates mono-, di- and polysaccharides, Structure of amino acids and their properties, Protein structure and their functions, Lipid phospholipid, glycolipid, steroids, Structure and function of nucleotides, Vitamins, Hormones.

Module 4 (12 hours)

Stereochemistry & Mechanism of Bio-transformations

Stereoisomerism of Chiral molecules, Optical activity, Specific rotation, Chiral centres and number of stereoisomers, Racemization, Kinetic Resolution, D.L and R,S nomenclature, Chemical synthesis of optically pure amino acids, Asymmetric oxidation, Asymmetric Reduction, CD, ORD and applications.

Reference:

1. Sengupta S, Basic stereochemistry of organic molecules, 2014, Oxford university press

SEMESTER III

BT13102 MICROBIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total hours: 42

Module1 (06 hours)

History of Microbiology, Types of microbes, Prokaryotes and eukaryotes, General introduction to viruses, bacteria, fungi and protozoa, Study of microbes using microscopes, Phase contrast and electron microscope, Structure of viruses, bacteria, fungi and protozoa.

Module 2 (14 hours**)**

Isolation of pure cultures, Counting of microorganism using microscopes and pour plating, Characterization of microbes by biochemical test and 16S ribosomal RNA homologies, Reproduction of viruses, bacteria and fungi. Staining of microbes, Growth of microbes, Growth curve, Growth factors, Nutritional requirements for growth.

Module 3 (12 hours**)**

Introduction to microbial genetics, Nature of bacterial variation, Fluctuation test, Selection of bacterial mutants, Basis of Biochemical Genetics, Fine structure analysis of bacteriophage, Microbial metabolism, Aerobic and anaerobic processes, Heterotrophic CO2 fixation, Photophosphorylation in bacteria, Secondary metabolism.

Module 4 (10 hours)

Microbial pathogenecity and control by physical and chemical methods, Microbial pathogens, Environmental microbiology including water and soil microbiology and microbial control

References:

1. M.J. Pelczar, E.C.S. Chan, and N.R. Krieg, Microbiology, 5th Edn., McGraw-Hill, 2007.
2. R.Y. Stanier, J.L. Ingraham, M.L. Wheelis, and P.R. Painter, The Microbial World, 5th Edn., Macmillan, 1987.
3. L.M. Prescott, J.P. Harley, and D.A. Klein, Microbiology, 6th Edn., McGraw-Hill, 2005.
4. D. Freifelder, Microbial Genetics, 2nd Edn., Narosa Publishing House, 1994.
5. J. Heritage, E.G.V. Evans, and R.A. Killington, Introductory Microbiology, 1st Edn., Cambridge University Press, 1999.
6. L.E. Casida, Industrial Microbiology, 99th Edn., New Age International (P) Limited, 1996.
7. W. C. Frazier and D. C. Westhoff, Food Microbiology, McGraw-Hill, 1988.

SEMESTER III

BT13103 BIOCHEMISTRY

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total hours: 42

Module 1 (16 hours**)**

Glycolysis, TCA cycle, Glyoxylate cycle, Gluconeogenesis, β-Oxidation of fatty acids, Omega oxidation, Ketone bodies, Biosynthesis and degradation of amino acids, Regulation and disorders of amino acid metabolism, Biosynthesis of fatty acids, Eicosanoids, Triglycerols, Degradation of cholesterol and steroids, Photosynthesis-photosystem I and photosystem II,

Module 2 (09 hours)

Biosynthesis and catabolism of purines and pyrimidine, Preliminery idea of De novo synthesis and Salvage pathway, Regulation and disease due to defect in nucleotide metabolism

Module 3 (11 hours)

Oxidative phosphorylation, Role of membrane-bound carriers in electron transfer, Synthesis of ATP, Regulation of oxidative phosphorylation, Uncouplers, Biological transport, structure and properties of biological membranes, passive transport and active transport, glucose, Na^+ and K^+ transport.

Module 4 (10 hours)

Introduction to structure of deoxyribonucleic and ribonucleic acid, Base pairing, Base stacking, Stabilized forms of DNA-A, B and Z forms, Melting of DNA double helix

References:

1. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 4th Edn, WH Freeman and Company, 2005.

2. J.M. Berg, J.L. Tymoczko, and L. Stryer, Biochemistry, 6th Edn., WH Freeman and Company, 2007.

3. R. H. Garret and C. M. Grisham, Biochemistry, 3rd Edn., Brooks Cole, 2004.

4. D. Voet and J.G. Voet, Biochemistry, 3rd Edn., John Wiley & Sons Inc., 2004.

5. G.L. Zubey, Biochemistry, 4th Edn,Wm. C. Brown Publications, 1998.

6. W. H. Elliot and D.C. Elliot, Biochemistry and Molecular Biology, 4th Edn, Oxford University Press, USA, 2009.

SEMESTER III

BT13104 THERMODYNAMICS IN BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total hours: 42

Module 1 (11 hours)

Systems, Open system and closed system, State and path function, Zeroth law of thermodynamics, Reversible and irreversible processes, First and second law of thermodynamics, Internal Energy, Enthalpy, Flow processes, Third law of thermodynamics, Concept of Entropy.

Module 2 (10 hours)

Behavior of ideal gases, Properties of gases showing non-ideal behaviour, Phase rule, Vapour-liquid equilibrium, Liquid-liquid equilibrium, Fugacity of pure gases, liquids and solids, Homogeneous chemical reactions, Effect of pressure and temperature on equilibrium constant.

Module 3 (10 hours)

Solution thermodynamic, Activity coefficient, Gibbs-Duhem's equation, Henry's law, Properties of fluids, Gibbs free energy, Entropy and heat capacity relation, Chemical Potential, Gibbs-Helmotz equation.

Module 4 (11 hours)

Thermodynamics and energetics of metabolic pathways, Oxygen requirement and heat generation in aerobic growth, Energy coupling (NADH and ATP), Thermodynamics of oxidation-reduction reactions, Energetics of DNA-protein interactions, receptor-ligand binding, transport across membrane- passive diffusion, facilitated diffusion and active transport

References:

1. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Edn., John Wiley & Sons Inc., 2006.

2. M.S. Bhatnagar, Pure and Applied Physical Chemistry,1st Edn., Wheeler Publisher, 1999.

3. D.T. Haynie, Biological Thermodynamics, 2nd Edn.,Cambridge University Press, 2008.

4. J.B. Ott and J. Boerio-Goates, Chemical Thermodynamics: Principles and Applications, 1st Edn., Academic Press, 2000.

5. D.V.S. Jain and S.P. Jauhar, Physical Chemistry: Principles and Problems, 1st Edn., Tata McGraw-Hill Publishing Company Limited, 1988.

6. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill Higher Education, 2nd Edn., 1986.

7. R.A.Alberty, Biochemical Thermodynamics: Applications of Mathematica (Methods of Biochemical Analysis), 1st Edn., Wiley-Interscience, 2006.

SEMESTER III

BT13105 FLUID MECHANICS

Pre requisite: Nil
Total hours: 42

L	T	P	C
3	1	0	3

Module 1 (13 hours)
Preliminaries, Concept of continuum, Properties of fluids – density – pressure – viscosity - surface tension - capillarity - vapour pressure, Fluid statics, Basic equations of fluid statics, Variation of pressure in a fluid, - Manometry - Forces on surfaces and bodies in fluids, Floatation - stability of bodies in fluid - metacentric height and its measurement, Fluids in rigid body motion, Fluid kinematics -Eulerian and Lagrangian description - local and material rates - deformation of a fluid element -strain rate-velocity relations, Graphical description of flow – streamlines - path lines - streak lines - stream tube, Fluid dynamics - concept of the control volume -Reynolds transport equation and its use to formulate fluid mechanics problems, Integral and differential forms of the continuity - momentum and energy equations, Illustrative examples.

Module 2 (11 hours)

One dimensional flow through pipes, Non viscous equation for the flow through a stream tube and along a stream line – Euler‘s equation – Bernoulli‘s equation, - Energy equation, Applications of the one dimensional equations - velocity and flow measuring devices and quasi steady problems, Laminar and turbulent flow through pipes - Hagen-Poiseuille equation - Darcy-Weisbach equation - pipe friction - Moody‘s chart - minor losses in pipes

Module 3 (10 hours)
Two dimensional incompressible inviscid flows – Vorticity - Vortex tube - Irrotational flow - Velocity potential, Stream function - relation between stream function and potential function in ideal flows - Equation of a streamline - governing equations, Fundamental flow patterns, Combination of basic patterns - Rankine half body - Rankine oval - Doublet and flow over a cylinder, Magnus effect and the calculation of lift on bodies.

Module 4 (8hours)
Plane viscous flow past bodies, The boundary layer - Prandtl‘s boundary layer equations, Blasius solution for the boundary layer over a flat plate, Karman‘s Momentum Integral equations - Solutions using simple profiles for the boundary layer on flat plate - calculation of skin friction drag.

Reference Books

1. Shames, I.H., ‗Mechanics of fluids’, Mc Graw Hill Book Co., 1986.

2. White, F.M., ‗Fluid Mechanics’, 6th Ed., Tata Mc Graw Hill, New Delhi, 2009.

3. Cengel, Y.A, Cimbala, John, M., ‗Fluid Mechanics, Fundamentals and Applications’, 7th Ed. Tata Mc Graw Hill, New Delhi, 2009.

4. Gupta, V., Gupta, S.K.., ‗Fluid Mechanics and its applications’, New Age International, New Delhi, 2005.

5. Som, S.K., and Biswas, G., ‗*Fluid Mechanics and fluid Machines’*, 2nd Ed., Tata Mc Graw Hill, New Delhi

SEMESTER III

BT13201 MICROBIOLOGY LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil
Total hours: 42

1. Asepsis techniques: (a) sanitation; (b) disinfestations; (iii) sterilization by autoclaving.

2. Preparation of culture media: (i) synthetic (N, C, Minerals, Growth factors) and (ii) complex.

3. Culturing of microorganisms.

4. Isolation of pure culture using streak plate and pour plate methods.

5. Isolation of microbes from soil/mouth flora / water samples: Enrichment culture.

6. Microbial count – (i) microscopy; (II) Nephelometry – turbidometry; (iii) dry weight.

7. Growth curve: bacterial population by turbidometry / Colony Forming Unit methods.

8. Storage / preservation of micro-organisms

9. Identification of microorganisms – (I) staining techniques (II) hanging drop (III) biochemical testing (Indole test, methyl red test, Voges Proskaeur test, citrate utilization, starch hydrolysis, urease test, catalase test, oxidase test, coagulase test).

10. Measurement of cell dimension by ocular and stage micrometer.

11. Antimicrobial assay: determination of zone of inhibition

References:

1. M.J. Pelczar, E.C.S. Chan, and N.R. Krieg, Microbiology, 5th Edn., McGraw-Hill, 2007.

2. D.L. Spetor and R.D. Goldman, Basic Methods in Microscopy, 1st Edn., Cold Spring Harbor Laboratory Press, 2005.

3. Stainer, et al. General Microbiology

SEMESTER III

BT13202 BIOCHEMISTRY LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Units, volume/weight measurements, concentration units, pH measurements, preparation of buffers, sensitivity, specificity.

2. Qualitative tests for carbohydrates, amino acids and lipids.

3. Determination of specific rotation of biomolecules (such as carbohydrates / amino acids) by Polarimetry

4. Quantitative determination of Carbohydrates by DNS method or phenol sulphuric acid test.

5. Quantitative determination of nucleic acids by spectrophotometry

6. Quantitative determination of proteins by Bradford and Lowry's methods

7. Separation of DNA by agarose gel electrophoresis.

8. Separation of biomolecules (e.g. amino acids / chlorophyll) by paper chromatography.

9. Enzyme activity assay: (i) filter paper assay for cellulose or (ii) GOD-POD assay for glucose.

References:

1. D. T. Plummer, An introduction to Practical Biochemistry, 3rd Edn, Mc. Grawhill Education India Private Limited (India) 1998.

2. K. Wilson, J. Walker, and J. M. Walker, Practical Biochemistry, 4th Edn., Cambridge University Press, 1994.

3. S. Rao and V. Deshpande, Experimental Biochemistry, 1st Edn., I K International Publishing House, 2005.

SEMESTER IV

BT14101 PROCESS CALCULATIONS

Prerequisite: Nil

Total hours: 42

L	T	P	C
3	0	0	3

Module 1 (06 hours)

Introduction - conversion of units, dimensional consistency, number of significant figures, precision and accuracy, mole concept and mole fraction, weight fraction and volume fraction, concentration of liquid solutions, stoichiometric principles, graphical differentiation and graphical integration, treatment and interpretation of data.

Module 2 (06 hours)

General material balance equation for steady and unsteady state, simplifications for steady-state processes without chemical reaction, element balance, material balance in processes like crystallization, drying, extraction, distillation, absorption, recycle, bypass and purge calculations.

Module 3 (08 hours)

Material balance problems with chemical reactions, stoichiometry of cell growth and product formation, elemental balances, electron balance

Module 4 (08 hours)

Energy balance - heat capacity, estimation of heat capacities, general energy balance, Enthalpy calculation procedures, Special cases *viz* spray dryer, distillation column, enthalpy change due to reaction: heat of combustion, heat of reaction for processes with biomass production, energy-balance equation for cell culture, for fermentation processes.

References:

1. K.V. Narayanan and B. Lakshmikuttyamma, Stoichiometry & Process Calculations, Prentice Hall Publishing, Delhi, 2006.

2. T.K. Ghose, A. Fiechter and N. Blakebrough , Advances in Biochemical Engineering (Volume 11), Springer-Verlag, New York, 1979.

3. B.I. Bhatt and S. M. Vora, Stoichiometry, 4th Edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2001.

4. O. A. Hougen, K.M. Watson and R. A. Ragatz, Chemical Processes Principles (Part-1): Material and Energy Balances, 2nd Edn., Asia Publication House, New Delhi, 2001.

5. R.M. Felder and R. W. Rousseau, Elementary Principle and Chemical Processes, 3 rd Edn., John Wiley & Sons inc., 2000.

SEMESTER IV

BT14102 BIOPROCESS PRINCIPLES

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)

Introduction to fermentation process, Overview of fermentation industry, Requirements of a fermentation process, Types of fermentation media, Design and optimization of media by response surface methodology, Configuration of bioreactor and ancillaries, Control of pH, temperature, dissolved oxygen and other environmental parameters.

Module 2 (11 hours)

Kinetics of cell growth, Unstructured kinetic models for microbial growth, Monod model, Product formation kinetics, Different modes of cultivation systems, Batch, continuous and fed batch, Oxygen requirements of microbial growth, mass transfer and determination of Kla, Factors affecting Kla.

Module 3 (10 hours)

Thermal death kinetics of microorganisms, Batch and continuous heat, Sterilization of liquid media, Filter sterilization of liquid media, Air sterilization, Design of sterilization equipment, Effluent treatment in bioprocesses, types of treatment methods, containment and effluent disposal.

Module 4 (11 hours)

Structured models of metabolism and growth, Compartment models, Models of product formation, Age distribution model for the production of antibiotics, Single cell models.

References:

1. J. E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn., McGraw Hill Publishers, 1986.

2. M. L. Shuler and F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.

3. P. M. Doran, Bioprocess Engineering Principles, 2nd Edition, Academic Press, 2005.

4. P. F. Stanbury, S. J. Hall and A. Whitaker, Principles of Fermentation Technology, 2nd Edn., Elsevier, Science & Technology Books, , 2005.

5. H. W. Blanch and D. S. Clark, Biochemical Engineering, 1st Indian Edn., Marcel Dekker Inc., 1997.

SEMESTER IV

BT14103 CELL BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (05 hours)

Cytoskeleton, Cytoskeleton and cell motility, Structure and functions of the Cell organelles like Nucleus, Ribosomes, Mitochondria, Chloroplast, Vacuoles, Peroxisomes. Endocytosis, exocytosis. Structure and functions of endoplasmic reticulum and golgi complex and their role in intracellular vesicular transport and protein sorting.

Module 2 (11 hours)

Cell cycle, Cell division, Mitosis and Meiosis, Molecules involved in the regulation of cell cycle, Cell adhesion and extracellular matrix, Cell junctions, Cell interactions in development and tissue formation, Control of cell numbers in multi- cellular organisms

Module 3 (11 hours)

Membrane bound receptors, Autocrine, Paracrine and Endocrine models of actions, Signal *transduction*, Second messengers, Role of cAMP in signal transduction, G proteins, Phosphorylation of protein kinases

Module 4 (16 hours)

Cell signaling processes like MAP kinase, AKT, WNT, Reception & Downstream signaling, Apoptosis, Necrosis, Cancer development.

References:

1. B. Alberts, A. Johnson, J. Lewis, and M. Raff, Molecular Biology of the Cell, 5th Edn., Garland Science, 2008.

2. H. Lodish, A.Berk, C.A. Kaiser, and M. Krieger, Molecular Cell Biology, 6th Edn., W. H. Freeman, 2007.

3. G. M. Cooper and R.E. Hausman, The Cell: A Molecular Approach, 4th Edn., Sinauer Associates Inc., 2006.

4. G. Karp, Cell and Molecular Biology, 5th Edn., Wiley, 2007.

5. J. E. Clis, N. Carter, K. Simons, and J. V. Small,, Cell Biology, 3rd Edn., Academic Press, 2005.

SEMESTER IV

BT14104 MOLECULAR BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (06 hours)

Chromosomal structure, Gene, DNA as a genetic material: Griffith's experiment, Hershey and Chase experiment, Characteristics of genetic code, Experiments on Genetic code, DNA Super coiling, Structure of t RNA, m RNA, r RNA

Module 2 (12 hours)

Replication of DNA in prokaryotes and eukaryotes, DNA polymerases and other proteins in replication, Models of replication, DNA damage and repair mechanism, Transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, RNA polymerase I, II and III in eukaryotes, Transcription factors, Post transcriptional processing of RNAs.

Module 3 (09 hours)

Translation in prokaryotes and eukaryotes, Mechanism of translation, Activation of amino acids, Initiation, Elongation and termination of translation, Codon usage, Post translational modifications.

Module 4 (15 hours)

Regulation of gene expression in prokaryotes, Concept of operon model: *lac*, *gal* and *trp* operons, Regulation of gene expression in eukaryotes, Chromatin assembly and nucleosome model, Gene silencing, DNA methylation, Genetic recombination

References:

1. J. D. Watson, T.A. Baker, S.P. Bell and A. Gann, Molecular Biology of the Gene, 6th Edn.,

Benjamin Cummings, 2007.

2. B. Lewin, Genes IX, 9th Edn., Jones & Bartlett Publishers, 2007.

3. D. Freifelder, Molecular Biology, 2nd Edn., Narosa Publishing House, 2008.

4. R. Weaver, Molecular Biology, 4th Edn., McGraw-Hill, 2007.

5. M. Ptashne, A Genetic Switch, 3rd Edn., Cold Spring Harbor Laboratory Press, 2004.

6. H. Lodish, A. Berk, C. A. Kaiser, M. krieger, M. P. Scott, A. Bretscher, H. Ploegh, and P.

Matsudaira, Molecular Cell Biology, 6th Edition, W.H. Freeman, 2007.

7. L. A. Allison, Fundamental Molecular Biology, 1st Edn., Wiley-Blackwell, 2007.

8. T. A. Brown, et al. Essentials in Molecular Biology

SEMESTER IV

BT14105 BIOSTATISTICS

L	T	P	C
2	0	0	2

Prerequisite: Nil
Total hours: 28

Module 1 (11 hours)

Introduction to Biostatistics, Collection and presentation of data, Plotting graphs, Bias in sampling and selection, Probability sampling, Random sampling, Measure of central tendency-arithmetic and geometric mean, Variance, Median, Measure of dispersion-range, Mean deviation, Standard deviation, Coefficient of variation

Module 2 (10 hours)

Correlation and regression analysis, Curve fitting-linear, non-linear and exponential, Hardy-Weinberg law, Parametric and Non-parametric test, ANOVA, MANOVA, Experimental designs, Sample surveys, Single and double blind experiments, limitations of experiments, Blocking and extraneous variables,

Module 3 (7 hours)

Estimation theory and testing of hypothesis, Sample size determination, point estimation, Interval estimation,

References:

1. B. Rosner, Fundamentals of Biostatistics, 6th Edn., Duxbury Press, 2005.

2. R. N. Forthofer, E. S. Lee, and M. Hernandaz, Biostatistics: A Guide to Design, Analysis and Discovery, 2nd Edn., Academic Press, 2006.

3. M. Pagano and K. Gauvreau, Principles of Statistics, 2nd Edn., Duxbury Press, 2000.

4. R. C. Elston and W. Johnson, Basic Biostatistics for Geneticists and Epidemiologists: A Practical Approach, 1st Edn., Wiley, 2008.

5. B. B. Gerstman, Basic Biostatistics: Statistics for Public Health Practice, 1st Edn., Jones & Bartlett Publishers, 2007.

6. E. S. Allman and J. A. Rhodes, Mathematical Models in Biology: An Introduction, 1st Edn., Cambridge University Press, 2003.

7. J. D. Murray, Mathematical Biology Vol. I & II, 3rd Edn., Springer, 2008.

SEMESTER IV

BT 14106 PRINCIPLE OF HEAT TRANSFER

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total Hours: 42

Module 1 (10 hours) Heat transfer - basic modes of heat transfer , conduction heat transfer , energy balance -integral and differential approaches , general heat conduction equations in Cartesian, cylindrical and spherical coordinates - initial and boundary conditions - one-dimensional steady state conduction with and without heat generation , temperature dependence of thermal conductivity , introduction to two dimensional steady state conduction, unsteady state heat conduction in one dimension - lumped heat capacity system , semi infinite solids with sudden and periodic change in surface temperature

Module 2 (12 hours) Convective heat transfer - Newton's law of cooling , Prandtl number, hydrodynamic and thermal boundary layer equations, laminar forced convection heat transfer from flat plates - similarity and integral solutions , internal flow and heat transfer - fully developed laminar flow in pipes , turbulent forced convection - Reynolds analogy , empirical relations in forced convection , natural convection - similarity and integral formulation of natural convection heat transfer from vertical plates , empirical relations in free convection., Condensation and boiling - film and drop wise condensation - film boiling and pool boiling, empirical relations for heat transfer with phase change, Introduction to mass transfer - Fick's law of diffusion – mass transfer coefficient - analogy between momentum, heat and mass transfer.

Module 3 (10 hours) Radiation heat transfer – electromagnetic radiation spectrum, thermal radiation, black body, gray body and white body, monochromatic and total emissive power, Planck‘s law, Stefan-Boltzmann law , Wein's Displacement law , absorptivity , reflectivity , transmissivity , emissivity , Kichhoff's identity , radiation exchange between surfaces - shape factors for simple configurations , heat transfer in the presence of re-radiating surfaces , radiation shields, surface and shape resistances , electrical network analogy.

Module 4 (10 hours) Applications of heat transfer like extended surfaces, critical insulation thickness, heat exchangers, heat pipes etc. Analysis of fins with constant area of cross section, Heat Exchangers - LMTD, correction factors, heat exchanger effectiveness and number of transfer units.-Design of heat exchangers –Compact heat exchangers , introduction to Heat pipes and their applications. Applications of radiative heat transfer, Multiple- mode heat transfer problems.

References 1 Holman, J.P., *Heat Transfer*, 9th ed., Tata McGraw Hill, 2005.

2 Incorpera, F.P. and De Witt, D.P., *Fundamentals of Heat and Mass Transfer*, John Wiley.

3 Kreith, F., *Heat Transfer*, International Text Book Company. 4 Gebhart, B., *Heat Transfer*, McGraw Hill.

SEMESTER IV

BT14201 BIOPROCESS LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Determination of growth curve of bacteria – estimation of biomass, calculation of specific growth rate, yield coefficient, utilization and product formation kinetics in shake flask culture.

2. Control of pH and temperature in a bioprocess.

3. Control of flow rates and pressure in a bioprocess.

4. Enzyme kinetics – Determination of Michaelis Menten parameters.

5. Enzyme immobilization and whole cell immobilization.

6. Kinetics of immobilized enzyme reactions.

7. Determination of volumetric oxygen transfer co-efficient (Kla) in a fermentor by static gassing out and sulphite oxidation methods.

8. Determination of mixing time in stirred tank reactor with Newtonian and Non-Newtonian fluids.

9. Determination of thermal death kinetics.

10. Time course curve for one biomolecule / bioprocess.

11. Product formation by microbial cells: (i) Ethanol; (ii) Acetic acid; (iii) Curd

References:

1. J. E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals 2nd Edn., McGraw Hill Publishers, 1986.

2. M. L. Shuler and F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.

SEMESTER IV

BT14202 MOLECULAR BIOLOGY LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Isolation of plasmid from *Escherichia coli (E.coli)*.
2. Transformation of *E.coli*.
3. Selection of recombinants (blue-white screening).
4. Restriction mapping of *E.coli*
5. Isolation of genomic DNA from *E.coli.*
6. Isolation of RNA from *E.coli* / Yeast
7. Cloning a DNA fragment in *E.coli* / Yeast vector
8. Restriction mapping of a DNA fragment cloned in a vector.
9. Amplification by PCR of cloned DNA fragment by Polymerase Chain Reaction.

References:

1. J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3 volume set, 3rd Edn., Cold Spring Harbor Laboratory Press, 2001.

2. J. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn., Benjamin Cummings, 2007.

3. I. H. Segel, Biochemical Calculations, 2nd Edn., Wiley, 1976.

SEMESTER V

BT 15101 IMMUNOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)

Introduction to immunity and immune system, Type of cells of immune system, Primary and secondary lymphoid organs, Types of immune responses; Innate, humoral and acquired immunity, Complement system and their biological functions, Antigens and their properties.

Module 2 (10 hours)

B lymphocytes and their maturation, Antibodies-their structures and functions, Idiotope and anti-idiotypic antibodies, Polyclonal antibodies, Hybridoma technology, Monoclonal antibodies-preparation and applications, Genetic control of antibody production.

Module 3 (10 hours)

Cell-mediated immunity, T lymphocytes-their maturation and functions, Antigen presenting cells, Mechanism of phagocytosis, Antigen processing and presentation, Major histocompatibility complex-types and their functions, T cell activation, Mixed lymphocyte reactions, Hypersensitivity reactions.

Module 4 (11 hours)

Autoimmune disorders, Primary and secondary immunodeficiency disorders, Immunological mechanisms in AIDS, cancer and allergies; Transplantation and graft rejection, Basic concepts of vaccine design and development, Antigen antibody interactions, Blood typing, Immunological techniques-double diffusion, ELISA and Radioimmunoassay.

References:

1. D. Male, J. Brostoff, D. Roth, and I. Roitt, Immunology, 7thEdn., Mosby, 2006.
2. T. J. Kindt, B.A. Osborne, and R.A. Goldsby, Kuby Immunology, 6thEdn.,W.H.Freeman, 2006.
3. A. K. Abbas and A.H.Lichtman, Basic Immunology, 3rdEdn.,Saunders, 2008.
4. S. K. Mohanty, Text Book of Immunology, Jaypee Brothers Medical Publishers, 2008.
5. R. Coico and G. Sunshine, Immunology: A Short Course, 6thEdn.,Wiley-Blackwell, 2009.

SEMESTER V

BT15102 BIOREACTOR DESIGN AND ANALYSIS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10hours)

Principles and kinetics of chemical and biochemical reactions - Fundamentals of homogeneous reactions for batch, plug flow, semi-batch, stirred tank/ mixed reactors, Energy and mass balances in biological reaction modeling, Configurations of different bioreactors, Classification based schuegerl, kafarov components of bioreactors and their operation.

Module 2 (11hours)

Reactors based on flow characteristics, ideal and non-ideal bioreactors, Design of ideal reactors, Material and energy balance, Batch bioreactor design, Performance equations for ideal reactors and non-isothermal reactors, Batch reactor analysis for kinetics (synchronous growth and its application in product production), Design and analysis of fed batch systems.

Module 3 (10 hours)

Definition of chemostat and turbidostat, Single flow single stage chemostat, Single flow multistage chemostat, Chemostat with recycle, Concepts of dilution rate and productivity analysis in CSTR, Plug flow analysis, Design of plug flow reactor, comparison of productivity in plug flow and chemostat.

Module 4 (11 hours)

Non-ideal flow in bioreactors, Reasons for non-ideality, Mixing time and Residence time distributions, Models for non-ideal reactors, plug flow with axial dispersion, tanks-n-series model, Multiphase bioreactors, Packed bed reactors, Air-lift reactors, Bubble column reactors, Fluidized bed reactors, Trickle bed reactors, Stability analysis of bioreactors; a case study with industrial relevance.

References:

1. A. Moser, Bioprocess Technology - Kinetics and Reactors, 2nd Edn., Springer Verlag, 1988.
2. O. Levenspiel., Chemical Reaction Engineering, 3rd Edn., John Wiley Eastern Ltd, 1998.
3. J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, 3rd Edn., McGraw-Hill, 1990.
4. B. Atkinson, Biological Reactors, 2nd Edn., Pion Ltd., 1974.
5. H. W. Blanch and D. S. Clark, Biochemical Engineering, 1st Edn., CRC Press, 1997

SEMESTER V

BT15103 DOWNSTREAM PROCESSING

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)

Introduction and significance of downstream processing in biotechnology, Requirement of purification, Characteristics of biological molecules, Classes of bio-products, physico-chemical basis of separation on different bioseparation processes.

Module 2 (10 hours)

Physical separation processes: Solid and liquid system, Electrophoretic separation. Flocculation, Centrifugation, Precipitation, Filtration, Settling, Cell disruption- Chemical, mechanical and enzymatic methods, Extraction, Absorption, Adsorption, Leaching, Crystallization and drying.

Module 3 (11 hours)

Membrane separation process, Separation of intracellular, extra-cellular, heat and photosensitive materials, case study with design aspect, Enzyme processing using Ultra filtration membranes, Use of membrane diffusion for separating and characterizing naturally occurring polymers.

Module 4 (10 hours)

Chromatographic methods, Partition chromatography, Ion exchange chromatography, Affinity chromatography, High performance liquid chromatography, Thin layer chromatography, Adsorption chromatography, Gas liquid chromatography, a case study with industrial relevance.

References:

1. P. A. Belter, E. L. Cussler, and W.S. Hu, Bioseparation: Downstream Processing for Biotechnology, 1st Edn., Wiley Interscience, 1988.

2. M. R. Ladisch, Bioseparations Engineering: Principles, Practice and Economics, 1st Edn., Wiley-Interscience, 2001.

3. J. D. Seader and E.J. Henley, Separation Process Principles, 2nd Edn., Wiley, 2005.

4. R. G. Harrison, P.W. Todd, S.R. Rudge, and D. Petrides, Bioseparations Science and Engineering, Oxford University Press, 2002.

5. M. L. Shuler and F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall, 2004.

6. K. Robards, P. E. Jackson, and P. R. Haddad, Principles and Practice of Modern Chromatographic Methods, Academic Press, 1995.

SEMESTER V

BT15104 INSTRUMENTAL METHOD AND ANALYSIS FOR BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (06 hours)

Centrifugation, Diffusion and Viscosity, Analytical and preparative ultracentrifugation, Dialysis, Ultrafiltration, Cell disruption, Sonication.

Module 2 (11 hours)

Basic principles of microscopic methods, Phase contrast and confocal microscopy, Principles of SEM & TEM, Fluorescence microscopy, Atomic force microscopy, Gel electrophoresis-Principles and instrumentation, Isoelectric focusing, Two dimensional gel electrophoresis, Pulse field gel electrophoresis.

Module 3 (10 hours)

Western, Southern and Northern blot, Immunofluorescence, Immunohistochemistry, Immunolabelling, Microarray, Flow cytometry (FACS), Computational data acquisition in bioprocess, Fermentation processes-gas analysis for O_2 and CO_2.

Module 4 (15 hours)

Absorption and Transmittance, Lambert-Beer's law, Instrumentation, Single beam and double beam spectrophotometers, Calibration and standardization, CD, ORD, Fluorescence, Phosphorescence, Absorption of X-rays, Monochromatic X-ray sources, X-ray diffraction, X-ray fluorescence, Mass spectrometry (Ionization and fragmentation), Basics of LC / MS, Tandem mass spectrometry, Nuclear magnetic resonance spectrometry, ESR spectroscopy.

References:

1. H. Willard, L. Merritt, J. Dean and F. Settle, Instrumental Methods of Analysis, 7thEdn., Wadsworth Pub. Co., 1988.

2. D. L. Pavia, G. M. Lampman, G. S. Kriz, and J. A. Vyvyan, Introduction to Spectroscopy, 4th Edn., Brooks Cole, 2008.

3. A. Messerschmidt, X-Ray Crystallography of Biomolecules: A Practical Guide, 1stEdn., Wiley- VCH, 2007.

4. I. D. Campbell and R. A. Dwek, Biological Spectroscopy, 1st Edn., Benjamin-Cumming Pub. Co.,1984.

5. R. A. Izydore, Fundamentals of Nuclear Magnetic Resonance Spectroscopy, 1st Edn., Durham Eagle Publications, 2007.

6. J. A. Glasel and M. P. Deutscher, Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Academic Press, 1995.

7. R. Westermeier, Electrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein Separations, 4th Edn.,Wiley-VCH, 2005.

SEMESTER V

BT15105 GENETIC ENGINEERING

Prerequisite: Nil

Total hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Basic concepts of recombinant DNA technology, Isolation, identification and characterization of DNA fragments; Plasmids, Phagemids, Cosmids, Restriction Enzymes, Type I, II and III, Nomenclature and sequence recognition, Restriction mapping.

Module 2 (12 hours)

Construction of *E. coli* vectors, Ligation of DNA fragments, Blunt end and cohesive end ligation, T4 DNA ligase, Use of Klenow fragment, T4 DNA polymerase, Alkaline phosphatase, Polynucleotide kinase, Screening of recombinant DNA fragments: Blue white screening, Cloning in M13 vectors, Yeast vectors, Mammalian vector, Expression vectors.

Module 3 (10 hours)

Hybridization techniques-Southern hybridization, northern hybridization; Labeling of probes, Nick translation, Construction of genomic DNA and cDNA libraries, Linkers, Adapters, DNA sequencing methods, Next generation sequencing methods.

Module 4 (10 hours)

Polymerase chain reaction, Primer design, Variants of polymerase chain reaction, DNA fingerprinting, DNA footprinting, Site directed mutagenesis, Restriction fragment length polymorphism, Application of genetic engineering in agriculture, medicine, Creation of synthetic bacteria for ethanol production.

References:

1. S. B. Primrose and R. Twyman, Principles of Gene Manipulation and Genomics, 7th Edn., Wiley-Blackwell, 2006.

2. D. S. T. Nicholl, An Introduction to Genetic Engineering, 3rd Edn., Cambridge University Press, 2008.

3. J. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn., Benjamin Cummings, 2007.

4. J. Dale and M. von Schantz, From Genes to Genomes: Concepts and Applications of DNA Technology, 2nd Edn., Wiley Interscience, 2007.

5. J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3 volume set, 3rd Edn., Cold Spring Harbor Laboratory Press, 2001

SEMESTER V

BT15201 IMMUNOTECHNOLOGY LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Culture of any animal cell line in RPMI /DMEM/ HAMS F12 medium
2. Cell trypsinization and cell counting by haemocytometer
3. Determination of cell viability by MTT and Trypan blue
4. Purification of lymphocytes and monocytes from peripheral blood.
5. Enzyme-link immunoabsorbant assay (ELISA)
6. Western blot
7. Identification of blood group
8. Immuno-electrophoresis
9. Haemagglutination reaction test
10. Fluorescence or Confocal microscopy
11. FACS: Cell cycle analysis , determination of apoptosis, mitochondrial membrane potential, autophagy ROS generation

References:

1. G. P. Talwar and S. K. Gupta, A Handbook of Practical and Clinical Immunology, Volumes 1 & 2, CBS Publications, 1992.

2. A. K. Chakaravarty, Immunology and Immunotechnology, 1st Edn., Oxford University Press, 2006.

3. D. P. Sites, J. D. Stobo, and J. U. Wells, Basic and Clinical Immunology, 8th Edn., Mcgraw-Hill/Appleton & Lange, 1994.

4. A. K. Abbas and A.H.Lichtman, Basic Immunology, 3rd Edn., Saunders, 2008.

5. S. K. Mohanty, Text Book of Immunology, Jaypee Brothers Medical Publishers, 2008.

6. R. Coico and G. Sunshine, Immunology: A Short Course, 6th Edn., Wiley-Blackwell, 2009.

SEMESTER V

BT15202 DOWNSTREAM PROCESSING LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Ammonium sulphate precipitation of enzymes.
2. High resolution purification by affinity chromatography.
3. High resolution purification by ion exchange chromatography.
4. Gel filtration chromatography of purified enzyme.
5. Recovery of citric acid from spent medium.
6. Lyophilisation, drying, crystallization techniques
7. Isolation of Natural products from Medicinal plants
8. High performance liquid chromatography: Detection of lipopeptide, carbohydrate molecule, pigments
9. Gas chromatography: Detection of ethanol, fatty acid methyl ester

References:

1. P. A. Belter, E. L. Cussler, and W.S. Hu, Bioseparation: Downstream Processing for Biotechnology, 1st Edn., Wiley-Interscience, 1988.
2. J. D. Seader and E.J. Henley, Separation Process Principles, 2nd Edn., Wiley, 2005.
3. E. Forgacs and T. Cserhati, Molecular Bases of Chromatographic Separation, 1st Edn., CRC-Press, 1997.
4. R. K. Scopes, Protein Purification: Principles and Practice, 3rd Edn., Springer, 1993.
5. J. N. Abelson, M. I. Simon, and M. P. Deutscher, Methods in Enzymology: Guide to Protein Purification, Volume 182, Academic Press, 1990.

SEMESTER VI

BT16101 BIOINFORMATICS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)

Introduction to Bioinformatics, Elementary commands and protocols, http, ftp, telnet; Nucleotide and Protein sequence databases, Genbank, NCBI, Pubmed, Data mining, Storage and retrieval, Modular nature of proteins, Substitution matrices, PAM, BLOSUM, Gap penalties, Similarity search, FASTA, BLAST, Perl programming.

Module 2 (10 hours)

Dynamic programming algorithm for sequence alignment, Multiple alignments, Common multiple alignment methods, Practical aspects of multiple alignments, Motifs and patterns, CLUSTALW, PROSITE, Hidden Markov model, Phylogenetic analysis, Elements of phylogenetic models, Determining the substitution model tree, Evaluating phylogenetic trees.

Module 3 (11 hours)

Predictive methods, Codon bias detection, Detection of functional sites in the DNA sequences, Protein identity based on structure, Secondary and tertiary structures of proteins, Plasmid construction, Restriction mapping of DNA, Primer design, Graphical representation of structures-DNA, RNA and Protein.

Module 4 (10 hours)

Sequencing of DNA,Shotgun DNA sequencing, Detection of SNPs and their relevance, Sequencing assembly, Gene predictions, Molecular prediction with DNA strings, *In silico* modeling, Comparative modeling, Molecular modeling in drug discovery.

References:

1. J. Pevsner, Bioinformatics and Functional Genomics, 2ndEdn., Wiley-Blackwell, 2009.

2. R. Drubin, S.R. Eddy, A. Krogh, and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1stEdn, Cambridge University Press, 1999.

3. W.H. Majoros, Methods for Computational Gene Prediction, 1stEdn.,Cambridge University Press, 2007.

4. D.W.Mount, Bioinformatics: Sequence and Genome analysis, 2ndEdn, Cold Spring Harbor Laboratory Press, 2004.

5. A.D. Baxevanis and B.F.F. Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edn.,Wiley-Interscience, 2004.

6. M. Zvelebil and J. Baum, Understanding Bioinformatics, 1st Edn., Garland Science, 2007.

SEMESTER VI

BT16102 SYSTEMS BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total hours: 42

Module 1 (06 hours)

Emergence of systems biology concept; Levels of Structural Organization in the human body; Interfacing of interdisciplinary domains in systems biology; Multimodal, multilevel and multi-scale approaches in systems biology.

Module 2 (14 hours**)**

Signal transduction pathways and cascades, information processing and transmission, pathway dynamics; Trees and sequences – graphs, connectivity, trees, flows in networks; Elements of process control – feedback, feed forward and cascade control, dynamics of closed loops, analogies with control of gene expression

Module 3 (12 hours**)**

Cellular metabolic networks, determination of simple motifs that are repeated in genetics;
guidelines for analyzing genetics circuits, layouts and representations, circuit dynamics; modeling, simulation and prediction of cellular events, micro-macro relations

Module 4 (10 hours)

Basic concepts of Bioelectricity and Mechanobiology and its implications in system biology Varied Experimental tools of systems biology, Application of system biology in Health care Future scope in system biology.

References:

1. M. Walhout, M. Vidal, J. Dekker, Handbook of Systems Biology: Concepts and Insights, 1st Edn, Elesevier
2. V. Danos, V. Schachter, Computational Methods in Systems Biology, Springer
3. S. Zoltan , S. Jörg, P. Vipul, System Modeling in Cellular Biology: From Concepts to Nuts and Bolts, The MIT Press
4. J. Wei, M. Winter, Mathematical Aspects of Pattern Formation in Biological Systems (Applied Mathematical Sciences), Springer.
5. R. Desalle, G. Giribet, W. Wheeler, Techniques in molecular systematics and evolution, Springer.

SEMESTER VI

BT16103 ENZYME KINETICS AND TECHNOLOGY

Prerequisite: Nil

Total hours: 42

L	T	P	C
3	0	0	3

Module 1 (11 hours)

Classification and nomenclature of enzymes, Hydrolases, Oxidoreductases, Peptidases, Esterases, Lyases, Kinases, ATPases, Ligases, Conformation and stereochemistry, Nomenclature: d/l, D/L, R/S, Importance of shapes in biological reactions, Chirality- diastereomers and prochiral molecules.

Module 2 (10 hours)

Basic catalytic principles, Factors contributing to enzymatic catalytic rates, Single and multi-substrate systems, Quantification of enzyme activity, Michaelis-Menten theory and kinetics, Initial velocity, Steady state kinetics, Enzyme assays and inhibition, Enzyme inhibition kinetics, Allosteric enzyme.

Module 3 (11 hours)

Effect of pH and temperature on enzyme activity, Role of metal ions in enzyme activity, The catalytic triad of serine proteases (chymotrypsin), Carbonic anhydrase, Protein kinases, Roles and mechanisms of coenzymes like pyridoxal phosphate, thiamine -pyrophosphate, folate, biotin, flavin, nicotinamide nucleotides and lipoate in enzyme catalytic activity.

Module 4 (10 hours)

Structural enzymology, Chemical modifications and site directed mutagenesis, Active sites as targets for drug action, Enzyme immobilization, Effect of immobilization on enzyme activity, Immobilized enzyme kinetics, Recombinant enzymes and their role in industry.

References:

1. A. Fersht, Enzyme Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding, 1st Edn., W. H. Freeman, 1998.

2. I. H. Segel, Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems, Wiley Classics Library Edn., Wiley-Interscience, 1993.

3. M. D. Trevan, Immobilized Enzymes: An Introduction and Applications in Biotechnology, John Wiley & Sons Inc, 1980.

4. P. A. Frey and A. D. Hegeman, Enzymatic Reaction Mechanisms, 1st Edn., Oxford University Press, USA, 2007.

5. N. P. Colowich, N. P. Kaplan, and K. Mosbach, Immobilized Enzymes and Cells, Methods in Enzymology, Part C, Vol.136, Academic Press, 1987.

SEMESTER VI

BT16104 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)

Introduction to environmental biotechnology, Role of microorganisms in nutrient cycling, Microbial flora of soil, Interaction among soil microorganisms, pollution monitoring, Xenobiotics, Factors affecting bioaccumulation, Measurement of bioaccumulation.

Module 2 (10 hours)

Introduction to water microbiology, Water borne infectious agents, Waste water treatment, BOD, COD, Microbial removal of Nitrogen and Phosphorous, Waste water treatment in dairy and sugar industries, Activated sludge process, Biological nutrient removal, Wastewater treatment efficiency treatment.

Module 3 (10 hours)

Solid waste management, Biotechnological process in managing hazardous waste, Biomedical waste, Textile industry waste, Use of different fuels and their environmental impacts, Biotransformation and biodegradation of pollutants, methods for determining biodegradability and biodegradation of lignocelluloses, polyaromatic hydrocarbons (PAH) and removal of volatile components, agricultural chemicals.

Module 4 (11 hours)

Use of microbes in bioleaching, Metal recovery, Microbial recovery of phosphate and petroleum, Biofertilizers, Mechanism of nitrogen fixing, Bioremediation, Phytoremediation, Biological control, Biotechnological processes for bioresource assessment, International effort for biodiversity management.

References:

1. B. E. Rittmann and P. L. McCarty, Environmental Biotechnology: Principles and Applications, 1st Edn., McGraw-Hill Publishing Co., 2001.

2. B. Bhattacharya and R. Banerjee, Environmental Biotechnology, 1st Edn., Oxford University Press, 2008.

3. R. W. Pickup and J. R. Saunders, Molecular Approaches to Environmental Microbiology, 1st Edn., Prentice Hall, 1996.

4. M. Roudhill, Extraction of Metals from Soils and Waters, 1st Edn., Springer, 2001.

5. W. C. Blackman Jr., Basic Hazardous Waste Management, 3rd Edn., CRC press, 2001

SEMESTER VI

BT16201 ENZYME TECHNOLOGY LABORATORY

Prerequisite: Nil

Total hours: 42

L	T	P	C
0	0	3	2

1. Isolation of enzymes (alpha amylase and acid phosphatase) from sweet potatoes.
2. Determination of molecular weight of isolated enzyme
3. Determination of enzyme activity.
4. Effect of substrate on enzymatic activity.
5. Effect of temperature on enzymatic activity.
6. Effect of inhibitors on enzymatic activity.
7. Enzyme activation kinetics
8. Enzyme immobilization by entrapment

References:

1. R. A. Dixon and R. A. Gonzales, Plant Cell Culture: A Practical Approach, 2nd Edn., Oxford University Press,1995.

2. K.-H. Neuman, A. Kuma, and J. Imani, Plant Cell and Tissue Culture: A Tool in Biotechnology: Basics and Application, 1st Edn., Springer, 2009.

3. J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3 volume set, 3rd Edn., Cold Spring Harbor Laboratory Press, 2001.

4. R. Eisenthal and M. Danson, Enzyme Assays: A Practical Approach, 2nd Edn., Oxford University Press,2002.

5. G. Marangoni, Enzyme Kinetics: A Modern Approach, 1st Edn., Wiley-Interscience, 2002.

6. H. Segel, Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Stead-State Enzyme Systems, Wiley Classics Library Edn., Wiley-Interscience, 1993.

SEMESTER VI

BT16202 BIOINFORMATICS LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil
Total hours: 42

1. Basics of sequence analysis Retrieving a sequence-nucleic acid/Protein
2. Use of FASTA searching-effect of different substitution matrices.
3. Pairwise comparison of sequences using BLAST
4. Alignment of multiple sequences
5. Primer design
6. Phylogenetic analysis-Parameters affecting evolutionary trees.
7. Secondary structure prediction of proteins.
8. Superimposition of structures
9. Identification of functional sites in Genes and Genomes
10. Restriction mapping of DNA sequences
11. Protein-ligand interactions
12. Development of a gene finder program
13. Comparison of two genomes

References:

1. J. Pevsner, Bioinformatics and Functional Genomics, 2ndEdn.,Wiley-Blackwell, 2009.

2. R. Drubin, S.R. Eddy, A. Krogh, and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1stEdn, Cambridge University Press, 1999.

3. W.H. Majoros, Methods for Computational Gene Prediction, 1stEdn.,Cambridge University Press, 2007.

4. D.W.Mount, Bioinformatics: Sequence and Genome analysis, 2ndEdn, Cold Spring Harbor Laboratory Press, 2004.

5. A.D. Baxevanis and B.F.F. Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edn.,Wiley-Interscience, 2004.

6. M. Zvelebil and J. Baum, Understanding Bioinformatics, 1st Edn., Garland Science, 2007.

SEMESTER VII

BT17101 ETHICS AND REGULATORY ISSUE IN BIOTECHNOLOGY

L	T	P	C
2	0	0	2

Prerequisite: Nil

Total hours: 28

Module 1 (7 hours)

Values in science, Misconduct in science, Negligence and error, Conflict of interest, Techniques used and treatment of data, Authorships, Plagiarism, Response to ethical violations. Biosafety.

Module 2 (7 hours)

Basic concepts of Intellectual Property Rights (IPR), IPR in the global economy-in international trade, Constitutional aspects of intellectual property, Principles of Patent laws, Historical background of patent laws, Non-governmental initiated community intellectual rights.

Module 3 (7 hours)

Patent laws and biotechnology, Evolution of biotechnology, Application of biotechnology, Concept of novelty and inventive steps in biotechnology, Microorganism and its application, Research and development investments, Patent laws related to microbial, pharmaceutical, environmental and agricultural inventions.

Module 4 (7 hours)

Conventions and agreements, TRIPS agreement, UPOV convention, Traditional knowledge, Rights of traditional knowledge holders, Peoples biodiversity register, Traditional knowledge in the international scenario.

References:

1. On Being a Scientist, 3rd Edn., National Academy Press, USA, 2009.
2. K.D. Sibley, The Law & Strategy of Biotechnology Patents, Butterworth-Heinemann, 1994.
3. L. Bently and B. Sherman, Intellectual Property Law, 3rd Edn., Oxford University Press, 2008.
4. S. M. McJohn, Intellectual Property: Examples and Explanations, 2nd Edn., Aspen Publishers, 2006.
5. A. R. Miller and M. H. Davis, Intellectual Property-Patents, Trademarks and Copyright in a Nutshell, 4th Edn., Thomson West, 2007.
6. J. Watal, Intellectual Property Rights in the WTO and Developing Countries, 1st Edn., Springer, 2001.

SEMESTER VII

BT17102 STRUCTURAL BIOLOGY

Prerequisite: Nil

Total hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Brief discussions on structure and function of amino acids, Nucleotides, Carbohydrates, Lipid, Cofactors, Vitamins, Hormones, Chirality of biological molecules

Module 2 (11 hours)

Composition and structure of proteins (Primary, secondary, tertiary, quaternary), alpha helix, beta sheet, coiled-coiled, Three dimensional conformations, Motifs, Fold, Significance of hydrogen bond, hydrophobic interaction, Electrostatic interaction , Vanderwaals interaction and dipole-dipole interaction, Ramachandran plot, Globular protein (Haemoglobin), Fibrous proteins (Collagen), Simple and conjugation protein (Definition and example), Protein folding: Chaperon model

Module 3 (11 hours)

Protein-protein interactions, Antigens and antibodies, Transcription factors, Protein-lipid interactions, Protein-DNA interactions, Ribosomes, Protein-carbohydrate interactions, Enzyme catalysis, Protein-ligand interactions, Scatchard plot, Cooperative interactions, Allosteric effect, Hill constants.

Module 4 (10 hours)

RNA folding and catalysis, X-ray spectroscopy, Optical spectroscopy, Mass spectrometry, Structure analysis using NMR and cryo-electron microscopy, Circular Diachroism spectroscopy

References:

1. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd Edn., Garland Science, 1999.

2. A. M. Lesk, Introduction to Protein Architecture: The Structural Biology of Proteins, 1st Edn., Oxford University Press, USA, 2004.

3. T. E. Creighton, Protein Function: A Practical Approach, 1st Edn., Oxford University Press, 2004.

4. G.G. Hammes, Thermodynamics and Kinetics for the Biological Sciences, 1st Edn., Wiley-interscience, 2000.

5. V. A. Bloomfield, D. M. Crothers, I. Tinoco, and J. E. Hearst, Nucleic Acids: Structures, Properties, and Functions, 1st Edn., University Science Books, 2000.

6. D. M. Freifelder, Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2nd Edn., W. H. Freeman, 1982.

7. G. E. Schulz and R.H. Schirmer, Principles of Protein Structure, 1st Edn., Springer, 1996.

8. P.W. Atkins, Physical Chemistry for the Life Sciences, 1st Edn., Oxford University Press, 2006.

SEMESTER VII

BT17401 PROJECT PHASE I

L	T	P	C
0	0	6	3

Prerequisite: Nil
Total hours: 42

The mini project work would be carried out in the Institute under the guidance of a faculty member. Students will be given the flexibility to come up with new ideas for their project proposals. A faculty coordinator will coordinate the work. An evaluation committee will be formed and students will present their work before this committee. Students will also prepare a report and submit it to the School of Biotechnology through their respective guides.

SEMESTER VIII

BT18401 PROJECT PHASE II

L	T	P	C
0	0	10	5

Prerequisite: Nil

Total hours: 84

The students will be given the flexibility to come up with project proposals in consultation with the faculty members. Students will do project individually. At the end of the semester, students will submit a brief report and will present their work to a committee consisting of the faculty members.

BT18402 SEMINAR

Prerequisite: Nil

Total hours: 42

L	T	P	C
0	0	2	1

Each student will identify a current topic of interest in biotechnology in consultation with a faculty member. Student will submit report on that topic and will give a presentation before a committee consisting of faculty members. The seminar topic shall be preferentially from published articles in peer reviewed journals.

Note: Mini Project is compulsory. Candidates are free to credit both Mini Project and Industrial Training.

List of Electives

Offered Elective courses					
Serial No.	**Subject Name**	**L**	**T**	**P**	**C**
1.	Biopharmaceutical Technology	3	0	0	3
2.	Cancer Biology	3	0	0	3
3.	Stem Cell Technology	3	0	0	3
4.	Plant Biotechnology	3	0	0	3
5.	Disease Pathology and Diagnostic Technology	3	0	0	3
6.	Medicinal Chemistry/Pharmacology	3	0	0	3
7.	Molecular Genetics	3	0	0	3
8.	Biocatalyst and Metabolic Engineering	3	0	0	3
9.	Biomaterial and Biopolymer Engineering	3	0	0	3
10.	Animal Biotechnology	3	0	0	3
11.	Biomechanics	3	0	0	3
12.	Food Engineering	3	0	0	3
13.	Nano-Biotechnology	3	0	0	3
14.	Molecular Modeling and Drug Designing	3	0	0	3
15.	Proteomics and Genomics	3	0	0	3
16.	Good Manufacturing Practices	3	0	0	3