DETAILED SYLLABI OF

B.Tech DEGREE PROGRAMME IN

BIOTECHNOLOGY

(Applicable from 2010 Admission onwards)

III-VIII SEMESTER

SCHOOL OF BIOTECHNOLOGY

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Semester 3

No	Code	Course	L	T	P	C	Category
1	MA2001	Mathematics-III	3	1	0	3	BS
2	BT2001	Cell Biology	3	0	0	3	PT
3	BT2002	Microbiology	3	0	0	3	PT
4	BT2003	Biochemistry	3	0	0	3	PT
5	BT2004	Biochemical Thermodynamics	3	0	0	3	PT
6	BT2005	Process Calculations	3	0	0	3	PT
7	BT2091	Microbiology Laboratory	0	0	3	2	PT
8	BT2092	Biochemistry Laboratory	0	0	3	2	PT
		Total	**18**	**1**	**6**	**22**	

N .B.
1. MA2001 Mathematics III- Common for all.

MA2001 MATHEMATICS III (PROBABILITY & STATISTICS)

Prerequisite: MA 1001

L	T	P	C
3	1	0	3

Total Hours: 56 Hrs

Module 1: Probability distributions (15 Hours)
Random variables, Binomial distribution, Hyper- geometric distribution, Mean and variance of a probability distribution, Chebyshev's theorem, Poisson distribution, Geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution, Weibull distribution. Joint distribution of two random variables.

Module 2: Sampling distributions and Inference concerning means (14 Hours)
Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Maximum Likelihood Estimation, Point estimation and interval estimation, point estimation and interval estimation of mean and variance, Tests of hypothesis, Hypothesis concerning one mean, Inference concerning two means.

Module 3: **Inference concerning variances proportions (13Hours)**
Estimation of variances , Hypothesis concerning one variance, Hypothesis concerning two variances , Estimation of proportions , Hypothesis concerning one proportion , Hypothesis concerning several proportions, Analysis of r x c tables, Chi – square test for goodness of fit.

Module 4: Regression Analysis (14 Hours)
Bi-variate Normal distribution- joint, marginal and conditional distributions. Curve fitting, Method of least squares, Estimation of simple regression models and hypothesis concerning regression coefficients, Correlation coefficient- estimation of correlation coefficient, hypothesis concerning correlation coefficient. Estimation of curvilinear regression models,
Analysis of variance:- General principles, Completely randomized designs, Randomized block diagram, Latin square designs, Analysis of covariance.

References:

1. Johnson, R. A., Miller and Freund's Probability and Statistics for Engineers, 6th edition., PHI, 2004.
2. Levin R. I. & Rubin D. S., Statistics for Management, 7th edition, PHI, New Delhi, 2000.
3. S.M. Ross, Introduction to Probability and statistics for Engineers, 3rd edition, Academic Press(Elsevier), Delhi, 2005.

BT2001 CELL BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Principles of cell structure and functions, Prokaryotic and Eukaryotic cells, Membrane structure and organization, Intracellular compartmentalization, Compositions of cell membranes, Transport across cell membranes, Electrical properties of membranes and Ion Channels, Membrane transport proteins and their mechanism of action.

Module 2 (11 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 3 (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, Apoptosis, Cancer development.

Module 4 (10 hours)
Membrane bound receptors, Autocrine, Paracrine and Endocrine models of actions, Signal amplifications, Second messengers, Role of cAMP in signal transduction, G proteins, Phosphorylation of protein kinases, Cell lines, Stem cells, Tissue Engineering.

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.

BT2002 MICROBIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module1 (11 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, Staining of microbes, Growth of microbes, Growth curve, Growth factors, Nutritional requirements for growth, Structure of viruses, bacteria, fungi and protozoa.

Module 2 (10 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.

Module 3 (11 hours)
Introduction to genetics of viruses and bacteria, 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 CO_2 fixation, Photophosphorylation in bacteria, Secondary metabolism.

Module 4 (10 hours)
Control of microorganisms by physical and chemical methods, Brief introduction to microbes causing Tuberculosis, Leprosy, AIDS, Malaria and Polio, Pathogenicity, Microbial resistance to drug, Soil microbiology, Microbes used in recombinant DNA technology.

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.

BT2003 BIOCHEMISTRY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
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, Glycolysis, TCA cycle, Vitamins, Hormones.

Module 2 (10 hours)
Biosynthesis and degradation of amino acids, Regulation and disorders of amino acid metabolism, Biosynthesis of fatty acids, Eicosanoids, Triglycerols, Degradation of cholesterol and steroids, β-Oxidation of fatty acids, Omega oxidation, Ketone bodies, Glyoxylate cycle, Gluconeogenesis.

Module 3 (11 hours)
Biosynthesis and degradation of ribonucleotides and deoxyribonucleotides, De novo pathways, Salvage pathways, Regulation of purine and pyrimidine biosynthesis, Introduction to structure of deoxyribonucleic and ribonucleic acid, DNA supercoiling, Photosynthesis-photosystem I and photosystem II.

Module 4 (10 hours)
Oxidative phosphorylation, Role of membrane-bound carriers in electron transfer, Synthesis of ATP, Regulation of oxidative phosphorylation, Biological transport, structure and properties of biological membranes, passive transport and active transport, glucose, Na and K transport.

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.

BT2004 BIOCHEMICAL THERMODYNAMICS

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, Protein folding and receptor-ligand binding.

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.

BT2005 PROCESS CALCULATIONS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 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 (10 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 (11 hours)
Material balance problems with chemical reactions, stoichiometry of cell growth and product formation, elemental balances, electron balance, degrees of reduction of substrate and biomass, yield coefficients of biomass and product formation, maintenance coefficients, oxygen consumption and heat evolution in aerobic cultures

Module 4 (11 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, 3rd Edn., John Wiley & Sons Inc., 2000.

BT2091 MICROBIOLOGY LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Sterilization techniques.
2. Preparation of culture media (I) broth type of media (II) agar.
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.
6. Growth curve measurement of bacterial population by turbidometry/Colony Forming Unit methods.
7. Growth curve of yeast
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) (IV) antibiotic sensitivity.
10. Microbial count – (I) microscopy (II) nephelometry – turbidometry (III) dry weight.
11. Food microbiology: Isolation of microbes from (I) milk (II) fermented food.
12. Isolation of bacteriophages from contaminated water.
13. Microbial production of metabolites.

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

BT2092 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. Quantitative determination of Carbohydrates.
4. Quantitative determination proteins.
5. Separation of plasma proteins by SDS-PAGE electrophoresis.
6. Separation of DNA by agarose gel electrophoresis.
7. Paper chromatography of amino acids.
8. Enzyme activity assays.

References:

1. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 4thEdn, WH Freeman and Company, 2005.
2. K. Wilson, J. Walker, and J. M. Walker, Practical Biochemistry, 4thEdn., Cambridge University Press, 1994.
3. S. Rao and V. Deshpande, Experimental Biochemistry, 1stEdn., I K International Publishing House, 2005.

Semester 4

No	Code	Course	L	T	P	C	Category
1	MA2002	Mathematics-IV	3	1	0	3	BS
2	BT2006	Bioprocess Principles	3	0	0	3	PT
3	BT2007	Molecular Biology	3	0	0	3	PT
4	BT2008	Biostatistics	3	0	0	3	PT
5	BT2009	Unit Operations	3	0	0	3	PT
6	BT2010	Bioenergetics & Metabolism	3	0	0	3	PT
7	BT2093	Bioprocess Laboratory	0	0	3	2	PT
8	BT2094	Molecular Biology Laboratory	0	0	3	2	PT
		Total	**18**	**1**	**6**	**22**	

N.B.
Mathematics IV-Common subject for all branches

MA2002 MATHEMATICS IV

L	T	P	C
3	1	0	3

Prerequisite: MA 1001, MA 1002

Total Hours: 56 Hrs

Module 1 Series Solutions and Special Functions (15 Hours)
Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Bessel functions of the second kind, Sturm- Liouville's Problems, Orthogonal eigenfunction expansions.

Module 2 Partial differential Equations (16 Hours)
Basic Concepts, Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Modelling: Vibrating String, Wave equation, Separation of variables, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Solution by Fourier series, Heat equation: solution by Fourier Integrals and transforms, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms.

Module 3 Complex Numbers and Functions (13 Hours)
Complex functions, Derivative , Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions.

Module 4 Complex Integration (12 Hours)
Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions.Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

References:

1. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
2. Wylie C. R. & Barret L. C., Advanced Engineering Mathematics, 6th Edition, Mc Graw Hill, New York,1995.
3. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT publishing company, 1994.
4. Kreyszig E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York, 1999

BT2006 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 $K_l a$, Factors affecting $K_l a$.

Module 3 (10 hours)
Sterilization, 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 cellular energetic and metabolism, Models of product formation, Age distribution model for the production of antibiotics, Single cell models, Models of gene expression and regulation, Models of plasmid expression and replication.

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., Macel Dekker Inc., 1997.

BT2007 MOLECULAR BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Mendel's laws of heredity, Law of segregation and independent assortment, Chromosomal theory of heredity, Double helix, Gene, Genetic code, Gene linkage and gene mapping, Griffith's experiment, DNA as a genetic material, Epigenetics, Gene interactions, Lethality, Central dogma of molecular biology.

Module 2 (10 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 (11 hours)
Translation in prokaryotes and eukaryotes, Mechanism of translation, Activation of amino acids, Initiation, Elongation and termination of translation, Translation machinery, Codon usage, Post translational modifications, Regulation of gene expression in prokaryotes, Concept of operon model, *lac, gal* and *trp* operons, Gene regulation in lamda phage.

Module 4 (10 hours)
Regulation of gene expression in eukaryotes, Chromatin assembly and remodeling, Homeobox and its role in the transcription of developmental genes, Gene silencing, Genetic recombination, Site-specific recombination in bacteria and viruses, Transposon and transposition, Retroviruses and oncogenes, Homologous recombination in eukaryotes.

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.

BT2008 BIOSTATISTICS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

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, Probability, Conditional probability, Genetic applications of probability, Hardy-Weinberg law, Discrete probability distributions-Binomial, Poisson, Forensic probability determination, Estimation of probabilities for multi locus system.

Module 3 (10 hours)
Experimental designs, Sample surveys, Single and double blind experiments, limitations of experiments, Blocking and extraneous variables, Statistical inference, Estimation theory and testing of hypothesis, Sample size determination, point estimation, Interval estimation, Simultaneous confidence intervals.

Module 4 (11 hours)
Microbial growth in a chemostat, Growth equations of microbial populations, Basic models for inheritance, Mutation and selection models, Genetic inbreeding models, Models of commensalisms, Mutualism and predation.

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.

BT2009 UNIT OPERATIONS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (12 hours)
FLUID MECHANICS: Introduction - nature of fluids, physical properties of fluids, fluid statics - pressure-density-height relationships, pressure measurement, units and dimensions, dimensional analysis, dimensionless numbers, Rayleigh method, Buckingham's pi theorem. Types of Fluid flow - laminar and turbulent, Reynolds number, Basic equations of fluid flow - Continuity equation and Bernoulli equation, flow through circular and non circular conduits – Hagen Poiseuille equation, Flow measurements – orifice meter, venturimeter, rotameter.

Module 2 (9 hours)
MECHANICAL OPERATIONS: Size reduction and sieve analysis, sedimentation equipments, mixing – types of mixers, power number, power consumption in mixing operation, Filtration – constant rate and constant pressure filtration, filtration equipments, Novel separation processes - reverse osmosis, dialysis, membrane separation, ion exchange - techniques and applications.

Module 3 (11 hours)
HEAT TRANSFER: Modes of heat transfer. Conduction - Fourier's law of heat conduction, Steady-state conduction through walls, Heat flow through a cylinder and sphere. Convection - Concepts of heat transfer by convection, Counter-current and parallel flows, Overall heat transfer coefficient, Log-mean temperature difference, Fouling factors. Heat transfer to fluids with phase change, Heat transfer from condensing vapours, Drop-wise and film type condensation, Theory of evaporation, Single effect and multiple effect evaporation, Design calculation for single and multiple effect evaporation, Heat transfer equipments - parallel and counter flow heat exchangers, Single pass and multi-pass heat exchangers, Design of various types of heat exchangers.

Module 4 (10 hours)
MASS TRANSFER: Humidification operations, Drying- theory and mechanism of drying, drying curves, classification of dryers; Distillation - vapour liquid equilibrium data, methods of distillation - batch, continuous, flash distillation, differential distillation, steam distillation, continuous rectification; Continuous fractionation; Liquid extraction - liquid-liquid equilibrium data, single stage extraction, counter-current multistage extraction, stage efficiency; Leaching - solid-liquid equilibria, leaching equipment for batch and continuous operations.

References:

1. W. L. McCabe, J. Smith, and P. Harriott, Unit Operations of Chemical Engineering, 6th Edn., McGraw-Hill Education, New York, 2001.
2. J.M. Coulson and J.F. Richardson, Chemical Engineering, Vol. I & Vol. II, 4th Edn., Butterworth - Heinemann, 1991.
3. J.P. Holman, Heat Transfer, 8th Edn., McGraw Hill, 1997.
4. R.E Treybal, Mass Transfer Operations, 3rd Edn., International Student Edition, Mc Graw Hill International, 1981.
5. N. de Nevers, Fluid Mechanics for Chemical Engineers, McGraw-Hill Education, New York, 1991.
6. W. L. Badger and J. T. Banchero, Introduction to Chemical Engineering, 1st Edn., McGraw- Hill Education, NewYork, 1955.
7. R.H. Perry and W.D. Green, Perry's Chemical Engineers' Hand Book, 7th Edn., McGraw Hill International Edition., New York, 2000.
8. D.Q. Kern, Process Heat Transfer, Mc Graw Hill Co. Inc, 1999.

BT2010 BIOENERGETICS AND METABOLISM

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Molecular basis of entropy, Concept of free energy and significance in metabolism, Biological oxidation-reduction reactions, redox potentials, High energy phosphate compounds, free energy of hydrolysis of ATP and sugar phosphates, ATP generation in bacterial system.

Module 2 (10 hours)
Coenzymes and Cofactors: Role and mechanism of action of $NAD^+/NADP^+$, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B_{12} coenzymes and metal ions with specific examples.

Module 3 (11 hours)
Metabolism; Basic concept and design, Glycolysis and Gluconeogenesis, Citric acid cycle, Hexose monophosphate shunt, Mitochondrial electron transport chain, Oxidative phosphorylation process, Urea cycle, Metabolism of amino acids, lipids and nucleic acids.

Module 4 (09 hours)
Photosynthesis: Structure and function of chloroplasts, Absorption of solar energy, Photosystems (I and II), Light and dark reactions, C3 and C4 plants, Calvin cycle, Pentose Phosphate pathway, Biochemistry of biological nitrogen fixation.

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. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill Higher Education, 2nd Edn., 1986.
4. R. Heinrich and S. Schuster, The Regulation of Cellular Systems, 1st Edn., Springer, 1996.
5. D. Voet and J.G. Voet, Biochemistry, 3rd Edn., John Wiley & Sons Inc., 2004.
6. G.L. Zubey, Biochemistry, 4th Edn,Wm. C. Brown Publications, 1998.W. C. Frazier and D. C. Westhoff, Food Microbiology, McGraw-Hill, 1988.

BT2093 BIOPROCESS LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Construction 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 Menton parameters.
5. Enzyme immobilization and whole cell immobilization.
6. Kinetics of immobilized enzyme reactions.
7. Determination of volumetric oxygen transfer co-efficient ($K_l a$) in a fermentor by static gassing out and sulphite oxidation methods.
8. Determination of Residence Time Distribution (RTD) of CSTR.
9. Determination of mixing time in stirred tank reactor with Newtonian and Non-Newtonian fluids.
10. Determination of thermal death kinetics.
11. Fermentation process of some biomolecules.
12. Measurement of ethanol production in a fermentor.

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.

BT2094 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. Isolation of plasmid from yeast *Saccharomyces cerevisiae*
3. Transformation of *E.coli*.
4. Selection of recombinants (blue-white screening).
5. Transformation of yeast.
6. Restriction mapping of *E.coli*/ Yeast vectors
7. Isolation of genomic DNA from *E.coli.*
8. Isolation of genomic DNA from yeast/ plants
9. Isolation of RNA from *E.coli*/ Yeast
10. Cloning a DNA fragment in *E.coli* / Yeast vector
11. Restriction mapping of a DNA fragment cloned in a vector.
12. Amplification of a cloned DNA fragment by Polymerase Chain Reaction.
13. PCR out of a gene/ DNA fragment from genomic DNA of yeast/ *E.coli*/plant.
14. Site directed mutagenesis of a cloned gene.
15. Southern hybridization.
16. Separation of chromosomes using Contour clamped homogenous electric field.

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. D. C. Amberg, D. J. Burke, and J. N. Strathern, Methods in Yeast Genetics, Cold Spring Harbor Laboratory Press, 2005.
3. J. D. Watson, T. A. Baker, S. P. Bell, and A. Gann, Molecular Biology of the Gene, 6th Edn., Benjamin Cummings, 2007.
4. C. Guthrie and G. R. Fink, Methods in Enzymology: Guide to Yeast Genetics and Molecular Cell Biology, Volume 350 (Part B), 1st Edn., Academic Press, 2002.
5. I. H. Segel, Biochemical Calculations, 2nd Edn., Wiley, 1976.

Semester 5

S.No	Code	Course	L	T	P	C	Category
1	BT3001	Immunotechnology	3	0	0	3	PT
2	BT3002	Bioreactor Design and Analysis	3	0	0	3	PT
3	BT3003	Downstream Processing	3	0	0	3	PT
4	BT3004	Instrumental Methods of Analysis	3	0	0	3	PT
5	BT3005	Environmental Studies for Biotechnology	3	0	0	3	OT
6		Elective-I	3	0	0	3	PT
7	BT3091	Immunology Laboratory	0	0	3	2	PT
8	BT3092	Downstream Processing Laboratory	0	0	3	2	PT
		Total	**18**	**0**	**6**	**22**	

BT3001 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, 7th Edn., Mosby, 2006.
2. T. J. Kindt, B.A. Osborne, and R.A. Goldsby, Kuby Immunology, 6th Edn.,W.H.Freeman, 2006.
3. A. K. Abbas and A.H.Lichtman, Basic Immunology, 3rd Edn.,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, 6th Edn.,Wiley-Blackwell, 2009.

BT3002 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, Types of bioreactors and their configurations, 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 bio reactors, Packed bed reactors, Air-lift reactors, Bubble column reactors, Fluidized bed reactors, Trickle bed reactors, Stability analysis of bioreactors.

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.

BT3003 DOWNSTREAM PROCESSING

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Importance of downstream processing in biotechnology, Problems, Requirement of purification, Characteristics of biological molecules, Classes of bio-products, physico-chemical basis of separation, Physico-chemical basis of 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.

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.

BT3004 INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Absorption and Transmittance, Lambert-Beer's law, Instrumentation, Single beam and double beam spectrophotometers, Calibration and standardization, Centrifugation, Diffusion and Viscosity, Analytical and preparative ultracentrifugation, Dialysis, Ultrafiltration, Cell disruption, Chromatographic techniques-paper, thin layer, column and gas chromatography.

Module 2 (11 hours)
Basic principles of microscopic methods, Phase contrast and confocal microscopy, Principles of SEM & TEM, Fluorescence microscopy, Gel electrophoresis-Principles and instrumentation, Isoelectric focusing, Two dimensional gel electrophoresis, Pulse field gel electrophoresis.

Module 3 (10 hours)
Western and Southern blot, Immunofluorescence, Immunohistocompatibility, Localization of cells in tissue immunoblotting, Enzyme-linked immunosorbent assay (ELISA), Computational data acquisition in bioprocess, Fermentation processes-gas analysis for O_2 and CO_2.

Module 4 (10 hours)
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, Polymerase chain reaction.

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, 4thEdn., 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, 1stEdn., Benjamin-Cumming Pub. Co., 1984.
5. R. A. Izydore, Fundamentals of Nuclear Magnetic Resonance Spectroscopy, 1stEdn., 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, 4thEdn.,Wiley-VCH, 2005.

BT3005 ENVIRONMENTAL STUDIES FOR BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Multidisciplinary nature of environmental studies - definition, scope and importance, need for public awareness. Natural resources and associated problems. Forest resources, multipurpose tree species, Nitrogen fixing tree species, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Conservation of natural resources.

Module 2 (10 hours)
Concept, structure and function of an ecosystem. Food chains, food webs and ecological pyramids. Biodiversity and its conservation. hot-spots of biodiversity, threats to biodiversity, conservation of biodiversity.

Module 3 (11 hours)
Environmental pollution – definition, cause, effects and control measures of - air pollution, water pollution, soil pollution, marine pollution, noise pollution, light pollution, thermal pollution, electronic waste, nuclear hazards. Bio-Indicators. Role of an individual in prevention of pollution, disaster management.

Module 4 (10 hours)
Social issues and the environment. Environmental ethics - issues and possible solutions. Issues involved in enforcement of environmental legislation, public awareness. Human population and the environment. Family Welfare Programme, environment and human health, human rights, value education, HIV/AIDS, women and child welfare, role of information technology in environment and human health.

References:

1. K.C. Agarwal, Environmental Biology, Nidi Publ. Ltd. Bikaner, 2001.
2. Jadhav, H & Bhosale, V.M. Environmental Protection and Laws. Himalaya Pub. House, Delhi, 1995.
3. Raina, M., I. Pepper and Gerba C. Environmental Microbiology, Academic Press, New York, 2006.
4. E.P. Odum, Fundamentals of Ecology. W.B. Saunders Co. USA, 1971.
5. Wanger K.D., Environmental Management. W.B. Saunders Co. Philadelphia, USA, 1998.
6. S.V.S. Rana. Essentials of Ecology and Environmental Science. Prentice Hall of India, New Delhi, 2005.

N.B. The syllabus is made in compliance with UGC and Supreme Court directions

BT3091 IMMUNOLOGY LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Handling the animals and raising antibodies.
2. Generation of antibodies against bovine serum albumin
3. Purification of antibodies
4. Purification of lymphocytes from peripheral blood.
5. Enzyme-link immunoabsorbant assay (ELISA)
6. Western blot
7. Identification of blood group
8. Isolation of monocytes from blood.
9. Immunoelectrophoresis
10. Identification of T cells by T cell rossetting
11. Haemagglutination reaction test.
12. Countercurrent Immunoelectrophoresis

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.

BT3092 DOWNSTREAM PROCESSING LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Solid-liquid separation by filtration.
2. Solid-liquid separation by centrifugation/sedimentation
3. Cell disruption methods.
4. Aqueous two phase extraction of biological products
5. Ammonium sulphate precipitation
6. Separation of Carbohydrates/amino acids by TLC.
7. High resolution purification by affinity chromatography.
8. High resolution purification by ion exchange chromatography.
9. Product polishing by gel filtration chromatography.
10. Separation of proteins and estimation of molecular weight by Sodium dodecyl sulfate-polyacrylamide gel electrophoresis.
11. Characterization of proteins by Western blotting.
12. Measurement of citric acid production in a fermenter.
13. Lyophilisation and drying
14. Crystallization

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 6

S.No	Code	Course	L	T	P	C	Category
1	BT3006	Plant Biotechnology	3	0	0	3	PT
2	BT3007	Bioinformatics	3	0	0	3	PT
3	BT3008	Genetic Engineering	3	0	0	3	PT
4	BT3009	Enzyme Kinetics & Technology	3	0	0	3	PT
5		Elective-II	3	0	0	3	PT
6	BT3093	Plant Biotechnology & Enzyme Kinetics Laboratory	0	0	3	2	PT
7	BT3094	Bioinformatics Laboratory	0	0	3	2	PT
8	BT3095/ BT3096	Mini Project/Industrial Training	0	0	3	1[@]	PT
		Total	**15**	**0**	**9**	**20**	

BT3006 PLANT BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module1 (10 hours)
Plant cell and tissue culture techniques and applications: Physico-chemical conditions for propagation of plant cells and tissues, Media composition, Growth regulators, Culture types, Plant regeneration, Organogenesis, Somatic embryogenesis, Germplasm conservation and cryopreservation, Protoplast Culture and Somatic Hybridization.

Module 2 (10 hours)
Plant natural products: Biosynthetic pathways, Metabolite profiling, Metabolic engineering, Bioreactor engineering using plant suspension culture; Approaches to increase productivity: Optimization of conditions, Precursors, Elicitors, Immobilization of plant cells, Organ culture and hairy root culture.

Module 3 (11 hours)
Plant genome: Structure, organization and regulation of plant genome ex-pression; Transposons, Organelle genomes: Chloroplast and mitochondrial genome, Plant transformation technology and transgenics: Direct transformation and *Agrobacterium* mediated transformation, T-DNA transfer, Ti and Ri plasmids; Vectors for plant transformation, Helper plasmids, Promoters, Reporters, terminators and selectable genes; Characterization of transgenics, Marker free methodologies.

Module 4 (11 hours)
Plant transgenics: integration, expression and localization; Transgenics conferring resistance to biotic and abiotic stress, Molecular pharming and industrial products, Metabolic engineering for primary and secondary metabolites, Molecular markers in plant genotyping, Techniques in molecular systematic.

References:

1. H. S. Chawla, Introduction to Plant Biotechnology, 2nd Edn., Science Publishers, 2002.
2. A. Slater, N. Scott, and M. R. Fowler, Plant Biotechnnology: The Genetic Manipulation of Plants, 2nd Edn., Oxford University Press, 2008.
3. L. Kyte and J. Kleyn, Plants from Test Tubes: An introduction to Micropropagation, 3rd Edn., Timber Press, 1996.
4. E. Galum, A. Breiman, and J. Barton, Transgenic Plants, Imperial College Press, 1997.
5. M. J. Chrispeels and D. E. Sadava, Plants, Genes, and Crop Biotechnology, 2nd Edn., Jones & Bartlett Publishers, 2003.
6. H. Daniell and C. Chase, Molecular Biology and Biotechnology of Plant Organelles: Chloroplasts and Mitochondria, 1st Edn., Springer, 2007.
7. R. Verpoorte and A. W. Alfermann, Metabolic Engineering of Plant Secondary Metabolism, 1st Edn., Springer, 2002.
8. M. K. Razdan, Introduction to Plant Tissue Culture, 2nd Edn., Science Publishers, 2003.
9. S. D. Gupta and Y. Ibaraki, Plant Tissue Culture Engineering, 1st Edn., Springer, 2005.

BT3007 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, CLUSTAW, 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, 2nd Edn.,Wiley-Blackwell, 2009.
2. R. Drubin, S.R. Eddy, A. Krogh, and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1st Edn, Cambridge University Press, 1999.
3. W.H. Majoros, Methods for Computational Gene Prediction, 1st Edn.,Cambridge University Press, 2007.
4. D.W.Mount, Bioinformatics: Sequence and Genome analysis, 2nd Edn, 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.

BT3008 GENETIC ENGINEERING

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

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, 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, Sanger Dideoxy sequencing method, Maxam-Gilbert sequencing method.

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, Cloning of Dolly the sheep, Creation of synthetic bacteria.

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.

BT3009 ENZYME KINETICS AND TECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

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 co-enzymes 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, Enzyme engineering and its 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.

BT3093 PLANT BIOTECHNOLOGY AND ENZYME KINETICS LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: Nil

Total hours: 42

1. Media preparation and plant growth regulators
2. Sterilization techniques for instruments/ancillaries and explants
3. Aseptic culture establishment by regeneration from seed
4. Protocol for organogenesis from axillary buds
5. *In vitro* culturing technique
6. *Agrobacterium* mediated transformation
7. Plasmid DNA isolation from *Agrobacterium*
8. Genomic DNA isolation from plant samples
9. Screening of transgenic plants using PCR
10. RAPD analysis for genetic homogeneity testing
11. Isolation of enzymes (alpha amylase and acid phosphatase) from sweet potatoes.
12. Determination of molecular weight of isolated enzyme
13. Determination of enzyme activity.
14. Effect of substrate on enzymatic activity.
15. Effect of temperature on enzymatic activity.
16. Effect of inhibitors on enzymatic activity.

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.

BT3094 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. Phylogenetic analysis-Parameters affecting evolutionary trees.
6. Secondary structure prediction of proteins.
7. Superimposition of structures
8. Identification of functional sites in Genes and Genomes
9. Restriction mapping of DNA sequences
10. Protein-ligand interactions
11. Development of a gene finder program
12. Comparison of two genomes
13. Primer design.

References:

1. J. Pevsner, Bioinformatics and Functional Genomics, 2nd Edn.,Wiley-Blackwell, 2009.
2. R. Drubin, S.R. Eddy, A. Krogh, and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1st Edn, Cambridge University Press, 1999.
3. W.H. Majoros, Methods for Computational Gene Prediction, 1st Edn.,Cambridge University Press, 2007.
4. D.W.Mount, Bioinformatics: Sequence and Genome analysis, 2nd Edn, 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.

BT3095 MINI PROJECT

L	T	P	C
0	0	3	1

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.

BT3096 INDUSTRIAL TRAINING

L	T	P	C
0	0	3	1

Prerequisite: Nil

Total hours: 42

Industrial training shall be as per the norms of the Institute. The list of industries where students can undergo training will be approved and published by School of Biotechnology. Training will be generally during the vacation so that normal classes will not be affected. The minimum duration of industrial training is 4 weeks. At the end of the training, students will prepare a report and submit it to School of Biotechnology. A committee consisting of faculty members will carry out assessment of the training. Students shall make a presentation before the committee.

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

Semester 7

S.No	Code	Course	L	T	P	C	Category
1	ME4104	Principles of Management	3	0	0	3	HL
2	BT4001	Ethics & Regulatory Issues in Biotech	2	0	0	2	PT
3	BT4002	Structural Biology	3	0	0	3	PT
4		Elective-III	3	0	0	3	PT
5		Elective-IV	3	0	0	3	PT
6		Elective-V	3	0	0	3	GE
7	BT4097	Project	0	0	6	3	PT
		Total	**17**	**0**	**6**	**20**	

N.B. ME4104 Principles of Management--- Common course

ME 4104 PRINCIPLES OF MANAGEMENT

Prerequisite: Nil

Total hours: 42

L	T	P	C
3	0	0	3

Module 1 (9 Hours)
Introduction to management theory, Characteristics of management, Management as an art – profession, Systems approach to management, Task and responsibilities of a professional manager, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures.

Module 2 (9 Hours)
Organizing – principles of organizing – organization structures, Directing – delegation – span of control – leadership – motivation – communication, Controlling.

Module 3 (12 Hours)
Decision making process– decision making under certainty – risk – uncertainty – models of decision making, Project management – critical path method – programme evaluation and review technique – crashing.

Module 4 (12 Hours)
Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management.

References:

1. Koontz, H., and Weihrich, H., *Essentials of Management: An International Perspective*, 8th ed., McGraw Hill, 2009.
2. Hicks, *Management: Concepts and Applications*, Cengage Learning, 2007.
3. Mahadevan, B., *Operations Management, Theory and Practice*, Pearson Education Asia, 2009.
4. Kotler, P., Keller, K.L, Koshy, A., and Jha, M., *Marketing Management*, 13th ed., 2009.
5. Khan, M.Y., and Jain, P.K., *Financial Management*, Tata-Mcgraw Hill, 2008.

BT4001 ETHICS AND REGULATIONS 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.

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.

BT4002 STRUCTURAL BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Levels of molecular organizations, Brief discussions of amino acids, Nucleotides, Carbohydrates, Lipid, Cofactors, Vitamins, Hormones, Chirality of biological molecules, Structure of proteins, Composition and primary structures of proteins.

Module 2 (11 hours)
Secondary structure of proteins-alpha helix, beta sheet, coiled-coiled, Three dimensional conformations, Motifs, Fold, Properties of structures, Ramachandran plot, Membrane proteins, Globular and Fibrous proteins, Quaternary structures-dimers, homodimers and heterodimers, tetramers; Protein folding.

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, Co-operative interactions, Allosteric effect, Hill constants.

Module 4 (10 hours)
Principles of nucleic acid structures, Base pairing, Base stacking, Stabilized forms of DNA-A, B and Z forms, Melting of DNA double helix, RNA folding and catalysis, X-ray spectroscopy, Optical spectroscopy, Mass spectrometry, Structure analysis using NMR and cryo-electron microscopy.

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.

BT4097 PROJECT

L	T	P	C
0	0	6	3

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 form groups having maximum of four members. 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.

Semester 8

S.No	Code	Course	L	T	P	C	Category
1	MS4003	Economics	3	0	0	3	HL
2		Elective-VI	3	0	0	3	PT
3		Elective-VII	3	0	0	3	PT
4		Elective-VIII	3	0	0	3	GE
5	BT4098	Seminar	0	0	2	1	PT
6	BT4099	Project	0	0	10	4	PT
		Total	**12**	**0**	**12**	**17**	

N.B. MS4003 Economics--- Common course

MS 4003 ECONOMICS

Prerequisite: Nil

Total hours: 42

L	T	P	C
3	0	0	3

Module 1 (9 hours)
General Foundations of Economics; Nature of the firm; Forms of organizations-Objectives of firms-Demand analysis and estimation-Individual, Market and Firm demand, Determinants of demand, Elasticity measures and business decision making, Theory of the firm-Production functions in the short and long run

Module 2 (11 hours)
Cost concepts- Short run and long run costs- economies and diseconomies of scale, real and pecuniary economies; Product Markets; Market Structure- Competitive market; Imperfect competition (Monopoly, Monopolistic & Oligopoly) and barriers to entry and exit -Pricing in different markets

Module 3 (11 hours)
Macro Economic Aggregates-Gross Domestic Product; Economic Indicators; Models of measuring national income; Inflation ; Fiscal and Monetary Policies ; Monetary system; Money Market, Capital market; Indian stock market; Development Banks; Changing role of Reserve Bank of India

Module 4 (11 hours)
International trade - Foreign exchange market- Balance of Payments and Trade-Effects of disequilibrium in BOP on business- Trade regulation- Tariff versus quotas- International Trade and development and role of international institutions (World Bank, IMF and WTO) in economic development.

References:

1. Gregory.N.Mankiw, "Principles of Macro Economics", Cengage Learning,4th Edition, 2007.
2. Gregory.N.Mankiw, "Principles of Macro Economics", Cengage Learning,4th Edition, 2007
3. Gupta, S.B."Monetary Economics", S. Chand & Co., New Delhi,4th Edition,1998.
4. Guruswamy,S. "Capital Markets", Tata McGraw Hill, New Delhi,2nd edition ,2009
5. Misra, S.K. and V.K. Puri, "Indian Economy – Its Development Experience", Himalaya Publishing House, Mumbai, 27th Edition,2009
6. Pindyck, R.S,, D.L Rubinfield and P.L. Mehta , "Microeconomics", Pearson Eductaion,6th Edition, 2008
7. Samuelson, P.A. and W.D. Nordhaus , "Economics" ,Tata McGraw Hill, New Delhi. 1998.
8. William .J.Baumol and Alan.S. Blinder, "Micro Economics Principles & Policy", Cengage Learning, Indian Edition 9th edition, 2009.

PN : Supplementary materials would be suggested / supplied for select topics on Indian economy

BT4098 SEMINAR

L	T	P	C
0	0	2	1

Prerequisite: Nil

Total hours: 42

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.

BT4099 PROJECT

L	T	P	C
0	0	10	4

Prerequisite: Nil

Total hours: 140

The project work started in the seventh semester shall preferentially continue in this semester. The students will complete the project work in this semester and present it before the assessment committee. The assessment committee as constituted in the seventh semester will assess the various projects for the relative grading and group average. The guides will award the grades for the individual students depending on the group average. Each group will submit the copies of the completed project report signed by the guide to the School of Biotechnology. The Head of School of Biotechnology will certify the copies and return them to the students. One copy will be kept in the departmental library.

List of Electives

No	Code	Course	C	S
1	BT3021	Cytogenetics	3	5
2	BT3022	Biopharmaceutical Technology	3	5
3	BT3023	Food Biotechnology	3	5
4	BT3024	Bioreaction Engineering	3	6
5	BT3025	Environmental Biotechnology	3	6
6	BT3026	Herbal Biotechnology	3	6
7	BT4021	Marine Biotechnology	3	7
8	BT4022	Good Manufacturing Practices	3	7
9	BT4023	Protein Engineering	3	7
10	BT4024	Molecular Modelling & Drug Design	3	7
11	BT4025	Metabolic Engineering	3	7
12	BT4026	Animal Biotechnology	3	8
13	BT4027	Cancer Biology	3	8
14	BT4028	Nanobiotechnology	3	8
15	BT4029	Mineral Biotechnology	3	8
16	BT4030	Human Physiology	3	8
17	BT4031	Stem Cell Biotechnology	3	8

BT 3021 CYTOGENETICS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)

Structure of the chromosome , Prokaryotic and eukaryotic chromosomes, Plasmids, Episomes, transposons, Mitochondrial and plastid genomes, Euchromatin and heterochromatin, Chromatin and nucleosome, B-chromosomes and special types of chromosomes.

Module 2 (10 hours)

Alterations in chromosome structure, Duplications, Deficiencies, Inversions, Translocations– classification, identification, meiotic pairing, breeding and evolutionary roles.

Module 3 (10 hours)

Numerical changes in chromosomes, Haploidy, Polyploidy, Aneuploidy – classification, methods of production, identification and utility, Meiotic pairing and role in evolution.

Module 4 (11 hours)

Chromosome banding techniques – types and applications , *In-situ* hybridization. Induced mutation in plants and their application, Alien gene transfer through chromosome manipulation – whole genome, individual chromosome, individual gene, Molecular tools and their applications.

References:

1. D. Roy, Cytogenetics, 1st Edn., Alpha Science Intl Ltd, 2009.
2. S. L. Gersen and M.B. Keagle, The Principles of Clinical Cytogenetics, 1st Edn. Humana Press, 2010.
3. P.K. Gupta, Cytogenetics, 1st Edn., Rastogi Publications, 2005.
4. Y.-S. Fan, Molecular Cytogenetics: Protocols and Applications, 1st Edn., Humana Press, 2010.
5. S. Heim and F. Mitelman, Cancer Cytogenetics: Chromosomal and Molecular Genetic Abberations of Tumor Cells, 3rd Edn., Wiley-Blackwell, 2009

BT3022 BIOPHARMACEUTICAL TECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Introduction to the history of drugs and pharmaceutical industry, a brief study about drugs from different sources like plants, animals, microbes and minerals and their therapeutic uses, Introduction to different types of dosage forms: Liquid, semisolid, aerosol, capsules, and tablets, Different routes of drug administration.

Module 2 (11 hours)
Pharmacodynamics and pharmacokinetics: Dose-effect relationships, drug receptor theory, mechanism of drug action. Principles of pharmacokinetics, Compartment models, Parameters: Biological half life, Apparent volume, Renal clearance, Total body clearance; Absorption, Distribution of drugs, Biotransformation and bioavailability of drugs.

Module 3 (10 hours)
Introduction to biopharmaceutical products, Good manufacturing practices (GMP), manufacturing facilities for biopharmaceuticals, sources of biopharmaceuticals like *E. coli*, yeasts, animal cells, transgenic animals, transgenic plants, Insect-cell based systems, production of final product and analysis of biopharmaceuticals.

Module 4 (11 hours)
Production and purification of monoclonal antibodies, Application of monoclonal antibodies in therapy, diagnosis and research; Production of therapeutic hormones like insulin, glucagon, human growth hormone, gonadotrophins, Cytokines - Interferons, Interleukins I & II, Tumor Necrosis Factor (TNF), Nucleic acids and radioimmune conjugates.

References:

1. G. Walsh, Biopharmaceuticals Biochemistry and Biotechnology, 2nd Edn., John Wiley 2002.
2. L. Lachman, H. A. Lieberman, and J. L. Kanig, The Theory and Practice of Industrial pharmacy, 3rd Edn., Lea & Febiger, 1986.
3. J. P. Remington and A. Osol, Remington's Pharmaceutical sciences, 16th Edn., Mack Publications & Company, Easton, 1980.
4. L. S. Goodman, J. G. Hardman, L. E. Limbird, and A. G. Gilman, Goodman & Gilman's the Pharmacological Basis of Therapeutics, 10th Edn., McGraw-Hill, 2001.
5. S. B. Primrose, R. M. Twyman, and R. W. Old, Principles of Gene Manipulation, 6th Edn., Wiley-Blackwell, 2001.

BT3023 FOOD BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Introduction to food biotechnology, Food processing, Types of microorganisms used for food processing and their resources, Nutritional values of food, Use of enzymes in food industry, Factors affecting growth and survival of microorganisms in food, Single cell protein, Genetically modified food.

Module 2 (10 hours)
Fermented food products, Diary products-Fermented milk, Cheese, Butter, Fermented Meat, Fermented fish, Beverages and related products of baking, Beer, Vinegar, Mould fermentation, Non beverage plant products.

Module 3 (10 hours)
Food spoilage, Bacterial agents of food borne illness- *Clostridium, Salmonella, Vibrio,* Non-bacterial agents of food borne illness - Helminthes, protozoa, Algae, Fungi, Viruses, Genomics.

Module 4 (11 hours)
Food preservation, Role of chemical and enzymes in food preservation, Biochemical engineering for flavour and food production, Microbiology of food preservation-physical, chemical and biological based preservation system, Food standards.

References:

1. R. Angold, G. A. Beech, and J. Taggart, Food Biotechnology, 1st Edn., Cambridge University Press, 1989.
2. J. M. Jay, M. J. Loessner, and D. A. Golden, Modern Food Microbiology, 7th Edn, Springer, 2006.
3. K. Shetty, G. Paliyath, A. Pometto, and R. E. Levin, Food Biotechnology, 2nd Edn., CRC, 2005.
4. P. J. Green, Introduction to Food Biotechnology, 1st Edn., CRC, 2002.
5. M. Ruse and D. Castle, Genetically Modified Foods: Debating Biotechnology, Prometheus Books, 2002.

BT3024 BIOREACTION ENGINEERING

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Overview of biochemical reactions, reaction rate, factors affecting reaction rate, Reaction yield, General reaction kinetics for biological systems, yields in cell culture, Product kinetics in cell culture, Kinetics of substrate uptake in cell culture, Determination of cell kinetic parameters from batch data.

Module 2 (11 hours)
Interpretation of rate data, Data analysis by integral, differential and non-linear least square methods, General mole balance equations, Mole balance equations on batch, CSTR, PFR and PBR, Conversion, Design equations, Reactor sizing, Space time, Stoichiometric table for batch and flow systems.

Module 3 (11 hours)
Introduction to reactor design, Design of batch, semi-batch, CSTR, plug flow reactors, Ideal and non-ideal reactors, Design and analysis of non-ideal reactors, Mixing time and residence time distribution, RTD for ideal and non-ideal reactors, Models to calculate exit concentrations and conversions, Models for ideal reactors, Dispersion and tanks in series models for non-ideal reactors.

Module 4 (10 hours)
Heterogeneous biological reactions, Internal mass transfer and heterogeneous reaction rate, Analysis of concentration profiles with different kinetics, Minimizing mass transfer effects, Reactor design for heterogeneous systems, Airlift bioreactor, Packed bed reactor, Fluidized bed reactor, Introduction to biological reaction monitoring and control

References:

1. P. M. Doran, Bioprocess Engineering Principles, 2nd Edition, Academic Press, 2005.
2. Scott F. H., Elements of Chemical Reaction Engineering, 4th Edn., Prentice Hall of India, 2005.
3. Levenspiel, O., Chemical Reaction Engineering, 3rd Edn., Wiley Eastern Limited, 1998.
4. Smith J.M., Chemical Engineering Kinetics, Mc Graw Hill, 3rd Edn., 1981.
5. Froment, G.F. and Bischoff, K.B., Chemical Reactor Analysis and Design, 2nd Edn., John Wiley and Sons, 1990.
6. H. W. Blanch and D. S. Clark, Biochemical Engineering, 1st Edn., CRC Press, 1997.

BT3025 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Introduction to environmental biotechnology, Microorganisms, 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, PAH, 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, 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.

BT3026 HERBAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Introduction and future prospects of herbal biotechnology, Use of biotechnological tools in medicinal plant science, Transgenic herbal plants, Combinatorial biosynthesis as a new tool in the generation of novel natural products,Bioprocestechniques in herbal medicines, Bioanalytical methods and metabolomics.

Module 2 (11 hours)
Endophytes: plant-associated microbes as a new sourceof bioactive compounds, Bioprospecting: the search for bioactive lead structures from herbs, Biotechnological approaches for the production of plant-based chemotherapeutics and secondary metabolites, selection of high-yieldingcell lines, Production of therapeutic antibodies in plants.

Module 3 (11 hours)
Breeding of medicinal plants,Improvement of a plant population by selection,Improvement of selection response by specific techniques,Characterization of medicinal plants,Biochemistry of flavor compoundsand essential oils, Biotechnological applications of flavor compounds.

Module 4 (09 hours)
Intellectual property protection of plant biotechnology, Utility patents, Trade-Related Aspects of Intellectual Property Rights (TRIPS), Plant variety protection, Ethics of patenting plant biotechnology.

References:

1. D. J.Chadwick and J. Marsh,Ethnobotany and the Search for New Drugs, John Wiley & Sons, Chichester, 1994.
2. L.Zhang and A.L. Demain, Natural Products– Drug Discovery and Therapeutic Medicine, Humana Press, Totowa, 2005.
3. C. Bacon and J.F. White, Microbial Endophytes. Marcel Dekker, Inc., NewYork, 2000.
4. P.M. Dewick, Medicinal Natural Products. A Biosynthetic Approach, Wiley, New York, 2002.
5. K. G. Ramawat, Biotechnology of Medicinal Plants: Vitalizer and Therapeutic, Illustrated Edn., Science Pub., 2004.
6. M. Spinella, The Psychopharmacology of Herbal Medicine, 1st Edn., The MIT press, 2001.
7. K. Oksman-Caldentey and W.H. Barz, Plant Biotechnology and Transgenic Plants, 1st Edn., CRC press, 2002.
8. N. Farnsworth, Screening plants for new medicines, In: Wilson, E. (Ed.), Biodiversity, National Academy Press, pp. 83–97, 1988.

BT4021 MARINE BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Types of marine environment - physical, chemical and biological aspects, Marine organisms, Types of marine microbes and their biology, Structures of bacteria, fungi, algae, protozoa and viruses, Introduction to marine pharmacology, Microbial metabolites, Microbial interaction Microbes of Biotechnological importance, Primary and secondary metabolite.

Module 2 (11hours)
Bioaugmentation, Biofouling, Corrosion Process and control of marine structures, Bioremediation, Nutrient cycling, Bio-fertilization, Probiotics, Regulation of bacterial growth, Marine pollution-heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, Biological indicators and accumulators.

Module 3 (10 hours)
Marine resources assessment, Methods of surveying the living resources (Acoustic, Aerial and Remote sensing), Population study and Marine environment protection Population dynamics, Abundance and density, Growth and mortality, Conservation and management- *in situ* and *ex situ*, IUCN categorization, Marine biosphere reserves, Marine parks - heritage sites.

Module 4 (10 hours)
Chromosome manipulation in aquaculture, Hybridization, Ploidy induction, Gynogenesis, Androgenesis and sex reversal in commercially important fishes, Transgenic fish, Tools for disease diagnosis in cultivable organisms, Enzyme immuno assays, Dot immunobinding assay, Western blotting, Latex agglutination test, Monoclonal antibodies, DNA based diagnosis, Cryopreservation.

References:

1. M. Fingerman, R. Nagabhushanam and M.-F. Thompson. Recent Advances in Marine Biotechnology , Science Publishers I999.
2. P. Proksch, Frontiers in Marine Biotechnology, 1st Edn., Taylor & Francis, 2006.
3. G. Sanchez and E. Hernandez, Environmental Biotechnology and Cleaner Bioprocesses, 1st Edn., CRC press, I999.
4. P. Proksch, Frontiers in Marine Biotechnology, 1st Edn., Taylor & Francis, 2006.
5. M. Fingerman and R. Nagabhushanam, Molecular Genetics of Marine Organisms, Illustrated Edn., Science Pub., 2004.
6. D. Montet and R.C. Ray, Aquaculture Microbiology and Biotechnology, 1st Edn., Science, 2009.

BT4022 GOOD MANUFACTURING PRACTICES

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Implications of cGMP and the regulation for cGMPs. Planning of chemical plant sanitation program and construction factors. Hygienic design of food plants and equipments, Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials, Control of pests and microbes, Cleaning and Disinfection-physical, chemical and microbiological approach.

Module 2 (11 hours)
Introduction to Quality control and total Quality control in the chemical industry. Various Quality attributes of food such as size, shape, texture, color, viscosity and flavor. Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Food regulation and compliance. Food inspection and Food Law.

Module 3 (10 hours)
Critical quality control point in different stages of production including raw materials and processing materials. Food Quality and quality control including the HACCP system.

Module 4 (10 hours)
Federal Food and Drug law, BSTI laws, activities. Other food laws (legalization). Trade and company standards. Control by (national, international, social organizations, e.g., FAO, WHO, UNICEF, CAB, NSB, etc).

References:

1. P.K. Mukherjee, Quality Control of Herbal Drugs, 1st Edn., Business Horizons, 2002.
2. M.A. Potdar, Pharmaceutical Quality Assurance, 2nd Edn., Nirali Prakashan, 2007.
3. M.J. Allport-Settle, Current Good Manufacturing Practices, 1st Edn., CreateSpace, 2009.
4. B. Graham and J.D. Nally, Good Manufacturing Practices for Pharmaceuticals, 6th Edn., Informa Healthcare, 2006.
5. S.H. Willig and J.R. Stoker, Good Manufacturing Practices for Pharmaceuticals, 4th Rev Edn., Marcel Dekker, 1996.
6. C.T.S. Sibinga, P.C. Das and H.J. Heiniger, Good Manufacturing Practice in Transfusion Medicine, Springer, 1st Edn., 1994.
7. P. Carson, P. Carson and N. Dent, Good Clinical Laboratory and Manufacturing Practices, 1st Edn., Royal Society of Chemistry, 2007.

BT4023 PROTEIN ENGINEERING

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10hours)
Introduction to proteins and peptides, Different methods for protein isolation and purification, Industrial applications of protein engineering and scale-up of protein production, protein sequence comparison, multiple sequence alignment, data bank scanning, pattern matching; sequence structure comparison.

Module 2 (11 hours)
Mass spectroscopy and analysis of protein expression, Techniques of protein structure determination and prediction, Primary structure, Peptide mapping, Peptide sequencing-Edman degradation method, Secondary structures-Alpha turn, beta sheets, coil-coiled, hair pin, Tertiary structures- Domains, folding, denaturation and renaturation; Methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes. Post translational modifications

Module 3 (10 hours)
Structure functional relationship of DNA binding proteins, prokaryotic and eukaryotic transcription factors: Zn fingers, Helix-turn-helix motifs, leucine Zippers, DNA polymenrases, Membrane proteins and receptors, bacteriorhodopsin, epidermal growth factor and insulin receptors, and their interaction with effectors, protein phosphorylation, immunoglobulins, , enzymes: serine proteases, ribonuclesase, lysozyme.

Module 4 (11 hours)
Design and synthesis of peptides, methods to alter primary structure of proteins- specific modification, change of amino acid by DNA mutation, multiple substitution, chimeric proteins, Thermostability of proteins, Enhancement of catalytic activity of enzymes by protein engineering, Recombinant insulin, *de novo* protein design.

References:

1. D. Voet and J.G. Voet, Biochemistry, 3rd Edn., John Wiley & Sons Inc., 2004.
2. T. E. Creighton, Protein Function: A Practical Approach, 1st Edn., Oxford University Press, 2004.
3. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd Edn., Garland Science, 1999.
4. P.C.E. Moody, and A.J. Wilkinson, Protein Engineering, IRL Press, 1990.
1. Oxford, UK. S. J. Park and J. R. Cochran, Protein Engineering and Design, 1st Edn., CRC, 2009.
2. L. Alberghina, Protein Engineering for Industrial Biotechnology, 1st Edn., CRC, 2000.
3. Y. Nosoh and T. Sekiguchi, Protein Stability and Stabilization through Protein Engineering, Ellis Horwood Ltd, 1992.
4. S. J. Park and J. R. Cochran, Protein Engineering and Design, 1st Edn., CRC press, 2009.

BT4024 MOLECULAR MODELLING AND DRUG DESIGN

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Introduction to Molecular modeling, Methodology of molecular modeling, Molecular mimicry and structural similarities, Structural similarities and superimposition techniques, Chemical intuition, Limitations of chemical intuition, Types of programs available for molecular modeling.

Module 2 (10 hours)
Virtual Screening, Docking methods, Program GREEN grid, Three dimensional database searches, Three dimensional description of binding site and energy calculation, Basic concepts of molecular recognition. Active conformation.

Module 3 (10 hours)
Drug target classification- DNA, RNA and proteins, Target discovery and validation strategies, structure based drug designing, *de novo* design methodologies, receptor mapping, Design and development of combinatorial libraries for new lead generation, Quantitative structure-activity relationship (QSAR)

Module 4 (11 hours)
Drug development process, New lead in discovery strategies, Practice of computer assisted drug discovery (CADD), Use of CADD in pharmaceutical industries, Validity of computational models, Limitations of CADD support, Computational models, Development of software and hardware, Challenges and opportunities.

References:

1. N. C. Cohen, Guidebook on Molecular Modeling in Drug Design, 1st Edn., Academic Press, 1996.
2. P. V. Bharatam, Modeling and Informatics in Drug Design, 1st Edn., Wiley-Interscience, 2009.
3. K.I. Ramachandran, G. Deepa, and K. Namboori, Computational Chemistry and Molecular Modeling: Principles and Applications, 1st Edn., Springer, 2008.
4. D.C. Young, Computational Drug Design: A Guide for Computational and Medicinal Chemists, 1stHar/Cdr Edn., Wiley-Interscience, 2009.
5. L. Otvos, Peptide-Based Drug Design, 1st Edn., Humana Press, 2008.

BT4025 METABOLIC ENGINEERING

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Overview of metabolism, Basic concept of metabolic engineering, Cellular metabolism, Transport processes-Active and passive transports, Biosynthetic and degradation pathways of amino acids, nucleotides, fats, nucleotides,

Module 2 (10 hours)
Metabolic flux, Methods for metabolic flux analysis, Application of metabolic flux analysis, Amino acid production by bacteria, Metabolic flux analysis for glutamic acid and lysine biosynthetic networks, Fluxes in mammalian cell cultures, Flux analysis and design of culture media.

Module 3 (10 hours)
Regulation of metabolic pathways, Regulation of enzymatic activities, Enzyme kinetics, Reversible and irreversible inhibitions, Regulatory enzymes, Allosteric enzymes Cooperativity, Control of enzyme production at transcription, translation levels, Regulation of metabolic networks.

Module 4 (11 hours)
Metabolic control analysis, Control coefficient and elasticity, Functional genomics, proteomics, metabolomics, System biology, Application of metabolic engineering, Enhancement of product yield, Alteration of nitrogen metabolism, Production of antibiotics, vitamins, polyketides etc., Bioconversions.

References:

1. G. N. Stephanopoulos, A. A. Aristidou, and J. Nielson, Metabolic Engineering: Principles and Methodologies, 1st Edn., Academic Press, 1998.
2. N. V. Torres and E. O. Voit, Pathway Analysis and Optimization in Metabolic Engineering, 1st Edn., Cambridge University Press, 2002.
3. B. Kholodenko, Metabolic Engineering in the Post Genomic Era, New edition Edn., Taylor & Francis, 2004.
4. S. Cortassa, M.A. Aon, A.A. Iglesias, and D. Lloyd, An Introduction to Metabolic and Cellular Engineering, 1st Edn., World Scientific Pub. Co., 2002.
5. C. Smolke, The Metabolic Pathway Engineering Handbook, 1st Edn., CRC press, 2009.
6. R. Heinrich and S. Schuster, The Regulation of Cellular Systems, 1st Edn., Springer, 1996.

BT4026 ANIMAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Animal biotechnology-Scope, organ transplant, Moral Standing, State of the art, Development of animal tissue culture, Equipment and materials, Principles of sterile techniques, Types of tissues, Sources of tissues, Animal metabolism-Regulation, Reactant and product transport through mammalian cells.

Module 2 (11 hours)
Fertilization and Cloning, Conventional methods for animal improvement, Embryo biotechniques, Micro manipulation and cloning, Artificial insemination, Concept of nuclear transfer in cloning, Creation of Dolly, Stem cells, Reprogramming of adult cells, Oncogenesis and cell transformation.

Module 3 (10 hours)
Cell lines, Preservation of cell lines, Primary culture, Establishment of primary cell culture, Definite and continuous cell lines, Scale up of animal cell culture, Scale up of suspension culture, Nutritional requirement, Growth characteristics, Kinetics, Microcarrier attached growth, Reactors used.

Module 4 (11 hours)
Mammalian genome, Complexity of human genome, Disease genes, Gene therapy, Transgenic animals, Applications of transgenic animals and animal cell culture, Vaccine production, Genetic status of culture stocks, Chromosome manipulation, Molecular tools for the identification of diseases in animals, animal ethics.

References:

1. M. Moo-Young, Animal Biotechnology, 1st Edn., Pergamon, 1989.
2. R. Portner, Animal Cell Biotechnology: Applications to Biochemistry and Molecular Biology, 2nd Edn., Humana Press, 2007.
3. R. I. Freshney, Culture of Animal Cells: A Manual of Basic Technique, 5th Edn., Wiley-Liss, 2005.
4. R. Portner, Animal Cell Biotechnology: Methods and Protocols, 2nd Edn., Humana Press, 2007.
5. L.-M. Houdebine, Animal Transgenesis and Cloning, 1st Edn., Wiley, 2003.
6. M.J.T. Carrondo, B. Griffiths, and J.L.P. Moreira, 1st Edn., Springer, 1996.

BT4027 CANCER BIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Characteristics of cancer cells and the onset of cancer, Regulation of cell cycle, Natural history of tumor progression, Genetic basis of cancer, Mutations that cause changes in signal molecules, Signal switches, Tumor suppressor genes, Modulation of cell cycle in cancer, Types of cancers, Diet-cancer relationship.

Module 2 (11 hours)
Chemical carcinogenesis, Metabolism of chemical carcinogens, Targets of chemical carcinogens, Principles of physical carcinogenesis, Radiation carcinogenesis, Free radical aspects of carcinogenesis, Mechanism of virus-induced carcinogenesis, Hormones and cancer, Hormone-sensitive and hormone-producing tumors.

Module 3 (10 hours)
Oncogenes, Identification of viral and cellular oncogene products, Retroviruses and oncogenes, Detection of oncogenes, Growth factor signaling pathways in cancer, Genomic instability and DNA repair, Clinical significances of invasion, Heterogeneity of metastatic phenotype, Theory of invasion, Proteinases and tumor cell invasion.

Module 4 (10 hours)
Detection of different types of cancers, Advances in cancer detection, Prediction of aggressiveness of cancer, Different forms of cancer therapy: Chemotherapy, radiation therapy, immuno therapy, radio-immuno therapy; Hyperthermia and magnetic hyperthermia: basic principle with examples, advantages and limitations.

References:

1. L. M. Franks, and N. M. Teich, Introduction to the Cellular and Molecular Biology of Cancer, 3rd Edn., Oxford University Press, 1997.
2. M. R. Alison, The Cancer Handbook, Nature Publishing Group, 2002.
3. B. W. J. Mahy, Virology: A Practical Approach, IRL Press, Oxford, 1985.
4. B. Alberts, A. Johnson, J. Lewis, and M. Raff, Molecular Biology of the Cell, 5th Edn., Garland Science, 2008.
5. H. Lodish, A. Berk, C. A. Kaiser, and M. Krieger, Molecular Cell Biology, 6th Edn., W. H. Freeman, 2007.
6. G. M. Cooper, and R. E. Hausman, The Cell: A Molecular Approach, 4th Edn., Sinauer Associates Inc., 2006.
7. L. Pecorino, Molecular Biology of Cancer: Mechanisms, Targets and Therapeutics, 2nd Edn., Oxford University Press, 2008.

BT4028 NANOBIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Definition of nanotechnology, Nanofabrication, Nanolithography, Bottom-up versus top-down models, Biocomposite inorganic devices, Stents and seeds, implant coating, Microfluids: Basic fluid ideas, Microfluidic devices and their fabrication, potential of microfluidic devices in nanobiotechnology

Module 2 (10 hours)
Strategies of printing proteins on surfaces, Micrrocontact printing of proteins, Protein based nanostructures: S-layers, lipid chips, engineered nanopores, microbial nanoparticles, Magnetosomes: nanoscale magnetic iron minerals in bacteria, Bacteriorhodopsin and its applications, Surface biology and nanoanalytics

Module 3 (11 hours)
Function and application of DNA based nanostructures, DNA templated electronics, DNA-gold bioconjugates, Use of nanoparticles for identification of pathogenic microbes, Nanodiganostics, Rapid ex-vivo diagnostics, Biomaterials and gene therapy, Drug discovery: Drug discovery using nanoparticles, Nanosensors in drug discovery, Use of nanoimaging agents.

Module 4 (11 hours)
Introduction to bioMEMS, Biosignal transduction mechanisms, Chemical transducers, Electromagnetic transducers, Optical transducers, Application of bioMEMS, Recent developments in bioMEMS, Production of nanoparticles using microbes, Nano-labels.

References:

1. C. P. Poole and F. J. Owens, Introduction to Nanotechnology, 1st Edn., Wiley-Interscience, 2003.
2. C. M. Niemeyer and C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives, 1st Edn., Wiley-VCH, 2004.
3. F. Pinaud, Peptide-coated Quantum Dots: Applications to Biological Imaging of Single Molecules in Live Cells and Organisms, VDM Verlag Dr. Muller, 2009.
4. T. Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices and Applications, 1st Edn., CRC, 2007.
5. D. Martin, Nanobiotechnology of Biometric Membranes, 1st Edn., Springer, 2006.
6. C. Nicolini, Nanobiotechnology and Nanobiosciences, 1st Edn., Pan Stanford Pub., 2008.

BT4029 MINERAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Biogenesis, Ecology and Genetics, Ecological problems of biotechnology, Biobenefication, Biological conversion of coal to organic chemicals, Down-downstream processing, Bioflotation, Bioflocculation, Decrepitation, Oxidation metallurgy, Swelling and softening, Melting, Environmental control and mine site remediation, Biocorrosion and biofouling.

Module 2 (10 hours)
Biohydrometallurgy, Bioleaching, Methods are used to recover copper, zinc, gold and cobalt; Biodegradation, Biodegradation of xenobiotics, Removal of toxic metals and radionuclides from the environment, Microbial treatment of metal contaminated liquid effluents, Wastewater treatment, Bioaccumulation.

Module 3 (10 hours)
Biomineralization, Types of biomineral forming processes, Biomineral species, Biologically-controlled mineralization, Biologically induced mineralization, Geomicrobiology-Microbes and geochemical cycles, Biocrystallization, Biometrics and its application, Magnetotactic bacteria.

Module 4 (11 hours)
Bioremediation-Microbial physiology, bio-reactors, growth characteristics of microorganisms; Biochemistry of leaching microbes, Leaching characteristics, Biodiversity of sulfate-reducing bacteria, Remediation of metal pollutants by sulfate-reducing bacteria, Tank operations, Heap operations, Designing Operations.

References:

1. S. K. Kawatra and K. A. Natarajan, Mineral Biotechnology: Microbial Aspects of Mineral Benefication, Metal Extraction, and Environmental Control, Society for Mining, Metallurgy, and Exploration, 2001.
2. S.C. Bhatia, Handbook of Environmental Biotechnology, Vols. I to III, Atlantic Pub., 2008.
3. H. L. Ehrlich and C. L. Brierley, Microbial Mineral Recovery, McGraw-Hill, 1990.
4. E. R. Donati and W. Sand, Microbial Processing of Metal Sulfides, 1st Edn., Springer, 2007.
5. G. M. Evans and J.C. Furlong, Environmental Biotechnology: Theory and Applications, 1st Edn., Wiley, 2002.

BT4030 HUMAN PHYSIOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (11 hours)
Introduction of body as a whole, Cells and Tissue Organization, Blood and circulatory system- composition and functions of blood including their disorders, blood grouping and its significance, mechanism of coagulation, bleeding and clotting disorders, Physiology of heart, Blood circulation, Cardiac cycle, Cardiac output, Heart rate, Regulation of blood pressure, ECG.

Module 2 (11 hours)
Nervous system and Special senses-functions of the nervous system, structure and function of different neurons. Physiology of brain and spinal cord, Vital centers of medulla oblongata, Cerebral ventricles, Cranial nerves and their functions, Physiology and divisions of autonomic nervous System (ANS), Motor and sensory pathways, The special senses-physiology of hearing, sight, smell and taste.

Module 3 (10 hours)
Respiratory system, Digestive system and Urinary system-physiological aspects of respiration, Exchange of gases, Regulation of Respiration, Organization of gastro intestinal system, Physiology of digestion and absorption- liver, pancreas and bile, Organization of Urinary system - structure of nephron, Mechanism of urine formation, Regulatory functions of the kidneys, Hemodialysis.

Module 4 (10 hours)

Endocrine And Reproductive system- introductin to Endocrinology, physiology of Hypothalamus, Pituitary, Thyroid, Parathyroid, Adrenal and Pancreatic hormones and disorders of these glands. Reproductive system in male and female, menstrual cycle, production of gametes, fertilization, embryo development.

References:

1. A. Waugh, A. Grant, and J.S. Ross, Ross and Wilson Anatomy and Physiology in health and illness, 9th Edition, Churchill Livingstone, 2001.
2. A.C. Guyton and J.E. Hall, Text book of Medical Physiology, 11th Edn., Elsevier Saunders, Philadelphia, 2006
3. E. Widmaier, H. Raff, and K. Strang, Vander's Human Physiology, 11th Edn., McGraw-Hill, 2008
4. A. Davies, A. G. H. Blakeley, C. Kidd, Human physiology, Churchill Livingstone, 2001.
5. S.I. Fox, Human Physiology, 12th Edn., McGraw-Hill, 2010.
6. J. B. West, and N. B. Taylor, Best and Taylor's Physiological Basis of Medical Practice, 12th Edn., Lippincott Williams & Wilkins, 1996.
7. C.C. Chatterjee, Human Physiology 11th Edn., Vol I & II, Medical Allied Agency, Kolkata.

BT4031 STEM CELL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total hours: 42

Module 1 (10 hours)
Introduction to stem cell biology-classification of stem cells and their sources, similarities and differences between embryonic and adult stem cells, Blastocyst culture, Cryopreservation, Properties and application of Embryonic stem cells, Characterization of human embryonic stem cells, stem cells and their developmental potential.

Module 2 (11 hours)
Subcloning, spontaneous and controlled differentiation of human embryonic stem cells, Differentiation of embryonic stem cells *in vivo* and *in vitro,* Feeder free culture of human embryonic stem cells, Therapeutic cloning and its challenges, Differentiation of human embryonic stems cells into various cell types like cardiomyocytes, islet cells of the pancreas, neurons.

Module 3 (11 hours)
Reprogramming of somatic cells to a pluripotent state, Molecular bases of pluripotency, Role of the embryonic stem cell environment and various signal transduction cascades in maintaining pluripotency, Stem Cell Niches within mammalian tissues, Mechanisms of stem cell self-renewal, Cell cycle regulators in adult stem cells

Module 4 (10 hours)
Ethical considerations in stem cell research**,** Pre-clinical regulatory considerations, Manufacturing and characterization issues pertaining to stem cell products, Stem cell based therapies, genetically engineered stem cells, Therapeutic applications of stem cells for leukemias, Neurological diseases and injuries, heart disease and diabetes.

References:

1. A. Bongso, and E.H. Lee, Stem Cells: From Bench to Bedside, World Scientific Publishing Co., Singapore, 2005
2. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, Elsevier Academic press, 2006.
3. P. J. Quesenberry, G. S. Stein, B. Forget, and S. Weissman, Stem Cell Biology And Gene Therapy, Wiley-IEEE, 1998.
4. S. Sell, Stem Cells Handbook, Humana Press, 2004.
5. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Volume 1-Embryonic Stem Cells, Academic Press, 2004.
6. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Volume-2 Adult & Fetal Stem Cells, Academic Press, 2004.