SYLLABUS FOR B.TECH. (BIOTECHNOLOGY)

FIRST SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BA-121	Foundation course in Physico-Inorganic Chemistry – I	2	1	3
BA-123	Foundation course in Physics-I	2	1	3
BA-113	Life Sciences – I	3	1	4
BA-109	Mathematics – I	3	1	4
BT-115	Concepts in Biotechnology	2	1	3
IT- 105	Introduction to Computers	3	0	3
Practicals :				
BA-155	Chemistry - I Lab	0	2	1
BA-153	Physics - I Lab	0	2	1
BA-159	Life Sciences – I Lab	0	2	1
BT-161	Biotechnology Lab	0	2	1
IT -155	Computer Lab	0	2	1
IT -157	Engineering Graphics - I Lab	0	2	1
TOTAL		**15**	**5/12**	**26**

SECOND SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BA-128	Foundation Course in Physics-II	2	1	3
BA-108	Mathematics-II	3	1	4
BA-132	Foundation Course in Organic Chemistry-II	2	1	3
BA-122	Life Sciences II	3	1	4
BT-124	Laboratory Techniques in Biotechnology	3	1	4
IT -120	Electrical Science	3	1	4
Practicals :				
BA-156	Physics - II Lab	0	2	1
BA-166	Chemistry – II Lab	0	2	1
BA-168	Life Sciences - II LAb	0	2	1
BT-164	Laboratory Techniques in Biotechnology -Lab	0	2	1
IT -166	Electrical Science-Lab	0	2	1
TOTAL		**16**	**6/10**	**27**

THIRD SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BT-201	Microbiology	2	1	3
BA-203	Bioenergetics – I	3	1	4
BT-205	Cell Biology	3	1	4
BT-209	Genetics	2	1	3
BT-211	Biostatistics	2	1	3
CT-211	Chemical Engineering-I	3	1	4
Practicals:				
BA-253	Bioenergetics – I Lab	0	3	2
BT-251	Genetics-Lab	0	4	2
BT-255	Cell Biology-Lab	0	3	2
BT-257	Microbiology lab	0	3	2
TOTAL		**15**	**6/13**	**29**

FOURTH SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BT-202	Immunology	2	1	3
BT-204	Molecular Biology	3	1	4
BT-206	Enzyme Technology	3	1	4
BA-208	Bioenergetics – II	3	1	4
CT-212	Chemical Engineering-II	3	1	4
Practicals:				
BT-254	Molecular Biology -Lab	0	4	2
BT-256	Enzyme Technology-Lab	0	4	2
BA-258	Bioenergetics - II Lab	0	3	2
BT-258	Immunology –Lab	0	2	1
TOTAL		**14**	**5/13**	**26**

FIFTH SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BT-301	Plant Tissue Culture	2	1	3
BT-303	Microbial Processing Engineering	3	1	4
BT-305	Animal Biotechnology	3	1	4
BT-307	Recombinant DNA Technology & Applications	2	1	3
BT-309	Developmental Biology	2	1	3
Practicals:				
BT-351	Plant tissue Culture - Lab	0	3	2
CT-361	Chemical Engineering - Lab	0	3	2
BT-355	Animal Tissue Culture - Lab	0	3	2
BT-357	Rec. DNA Tech. & Appl.- Lab	0	3	2
BT-359	Developmental Biology - Lab	0	3	2
	TOTAL	**12**	**5/15**	**27**

SIXTH SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BT-302	Bioinformatics	3	1	4
BT-304	Food Biotechnology	2	1	3
BT-306	Plant Biotechnology	2	1	3
BT-308	Down Stream Processing	3	1	4
BT-310	Biosensor	2	1	3
BT-312	Biochemical Engineering & Biotechnology (Elective for CT Students)	2	1	3
Practicals:				
BT-352	Bioinformatics - Lab	0	3	2
BT-354	Food Biotechnology - Lab	0	3	2
BT-356	Plant Biotechnology - Lab	0	3	2
BT-358	Downstream / Microbial Processing-Lab	0	3	2
	TOTAL	**14**	**6/12**	**28**

SEVENTH SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BT-401	Stem Cells in Health Care	3	1	4
BT-403	Environmental Biotechnology	2	1	3
BT-405	Protein Biotechnology	2	1	3
BT-407	Commercialization, Marketing and Management of Biotechnological Products	3	1	4
HS-409	Writing Skills for Technical Purposes	3	1	4
Practicals:				
BT-451	Protein Biotechnology-Lab	0	3	2
BT-453	Environmental Biotechnology -Lab	0	2	1
BT-455	Field Trips	0	7	4
	TOTAL	**13**	**5/12**	**25**

EIGHTH SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BT-402	Industrial Biotechnology	3	1	4
BT-404	Intellectual Property Rights in Biotechnology	2	1	3
BT-406	Diagnostics Techniques	2	1	3
BT-408	Biosafety & Bioethics	2	0	2
Project workl/Viva-voce :				
BT-450	Project Work	0	18	18
	TOTAL	**9**	**3/18**	**30**

BA-121 FOUNDATION COURSE IN PHYSICO INORGANIC CHEMISTRY - I

1. **Chemical Bonding:** Ionic bond ; energy changes, lattice energy Born Haber Cycle, Covalent bond-energy changes, Potential energy curve for H_2 Molecule, characteristics of covalent compound, co-ordinate bond - Werner's Theory, effective atomic numbers, isomerism in coordinate compounds. Hydrogen bonding, Vander Waal's forces, hybridisation and resonance, Valance Shell Electron Repulsion theory (VSEPR). Discussion of structures of H_2O, NH_3, SiF_4. Molecular orbital theory, Linear combination of atomic orbitals (LCAO) method. Structure of simple homo nuclear diatomic molecule like H_2, N_2, O_2, F_2.

2. **Thermochemistry:** Hess's Law, heat of a reaction, effect of temperature on heat of reaction, at constant pressure (Kirchoff's Equation) heat of dilution, heat of hydration, heat of neutralization and heat of combustion, Flame temperature.

3. **Reaction Kinetics:** Significance of rate law and rate equations, order and molecularity, Determinations of order of simple reactions-experimental method, Equilibrium constant and reaction rates-Lindemann, collision and activated complex theories, complex reactions of Ist order characterstics of consecutive, reversible and parallel reactions-Steady state and non-steady state approach.

4. **Catalysis:** Criteria for Catalysis - Homogeneous Catalysis, acid-base, Enzymatic catalysis, Catalysis by metal salts, Heterogeneous catalysis - concepts of promoters, inhibitors and poisoning, Physiosorption, Chemisorption, Surface area, Industrially important process. Theories of Catalysis.

5. **Polymers:** Basic concepts & Terminology, such as monomers, Polymers, Functionality, Thermoplastics, Thermosets Linear, Branched, cross linked polymers etc. different definitions of molecular weight viz., Mw, Mn, Mv and then determinations, Industrial applications of polymers, Addition, condensation and Ionic polymerization's, solutions of polymers, good solvents, & bad solvent, solubility parameter, solutions viscosity and determination of intrinsic viscosity.

6. **Colloids:** Collidal state, classification of colloidal solution, true solution, colloidal solution and suspensions, preparation of sol, Purification of colloidal solutions, General properites and optical properites, stability of colloids, coagulation of lyphobic sols, electrical properties of sols, kinetic properties of colloids:- Brownion movement, size of colloidal particle, emulsions, gels, colloidal electrolytes and applications of colloids.

Text / Reference Books:

1. Inorganic Chemistry by J.D. Lee.
2. Physical Chemistry by Lewis.

BA-123 FOUNDATION COURSE IN PHYSICS - I

1. **Optics Interference:** Coherence and coherent sources, Interference by division of wavefront (Young's double slit experiment, Fresnels' biprism), Interference by division of amplitude (Thin films, Newton's rings,Michelson's Interferrometer,Fabry Perot Interferrometer

2. **Diffraction:** Fresnel and Fraunhoffer types of diffraction, Fraunhofer diffraction: Single slit, double slit, circular aperture and N-slit. Diffraction grating - wavelength determination, resolving power and dispersive power. Resolving power of optical instruments – Rayleigh criterion. Fresnel Diffraction: zone plate, circular aperture, opaque circular disc, narrow slit.

3. **Polarization:** Types of polarization, elliptically and circularly polarized light Brewster's law, Malu's law, Nicol prism, double refraction, quarter-wave and half-wave plates, optical activity, specific rotation, Laurent half-shade polarimeter.

4. **Lasers:** Introduction, Coherence, Einstein A and B coefficients, population inversion, Basic principle and operation of a laser, Types of lasers, He-Ne laser, Ruby laser, semi-conductor laser, holography - theory and applications

5. **Introduction to Optical fibre:** Types of optical fibres and their characteristics, (Attenuation and Dispersion) step index and graded index fibres, principle of fibre optic communication- total internal reflection, Numerical aperture, Fibre optical communication network- its advantages. Fibre optic sensors (qualitative)

6. **Nature of light and matter:** Particle nature of radiation- The Photoelectric effect, Compton effect. X-rays (continuous and characteristic), x-ray diffraction- Bragg's law. The origin of quantum theory- Planck's hypothesis, the wave nature of matter- wave-particle duality, matter waves (de Broglie hypothesis). Basic postulates of quantum mechanics - the wave function - its physical interpretation, the Schrodinger equation.

7. **The electromagnetic spectrum**: Sources of light, emission and absorption spectra, Brief introduction to spectroscopy (optical, magnetic resonance).

Text / Reference Books:

1. Modern Physics by A. Beiser.
2. Optics by A.K. Ghetak.
3. Modern Physics by Hallday & Resvik.
4. Introduction to Physical Optics by Jenkin & White.

BA-113 LIFE SCIENCES - I

1. **Origin of Life:** History of earth, theories of origin of life nature of the earliest organism.

2. **Varieties of life:** Classification, Five kingdoms, viruses (TMV, HIV, Bacteriophage), Prokaryote (Bacteria-cell structure, nutrition, reproduction), Protista, Fungi, Plantae and Animalia.

3. **Chemicals of life:** (Biomolecules)- Carbohydrates lipids, amino acids, proteins, nucleic acids, and identification of biomolecules in tissues.

4. **Cell:** The cell concept, structure of prokaryotic and eukaryotic cells, plant cells and animal cells, cell membrances, cell organelles and their function. Structure and use of compound microscope.

5. **Histology:** Maritimes (apical, intercalary, lateral) and their function; simple tissue (parenchyma, collenchymas, sclerenchyma); Complex tissue (xylem and phloem); Tissue systems (epidermal, ground, vascular); primary body and growth (root, stem, leaf); Secondary growth. Animal Epithelial tissue, connective tissue, muscle tissue and nervous tissue and their function in body.

6. **Nutrition:** Autotrophic (Photosynthesis) Pigment systems, Chloroplast, light absorption by chlorophyll and transfer of energy, two pigment systems, photosynthetic unit, phosphorylation and electron transport system, Calvin-Benson Cycle (C_3), Hatch Slack Pathway (C_4), Crassulacan Acid Metabolism (CAM), factors affecting photosynthesis; Mineral Nutrition in plants. Heterotrophic - Forms of heterotrophic nutrition, elementary canal in humans, nervous and hormonal control of digestive systems, fate of absorbed food materials; Nutrition in humans, Reference values.

7. **Energy Utilization:** (Respiration) - Structure of mitochondria, cellular respiration, relationship of carbohydrate metabolism to other compounds, Glycolysis, fermentation, formation of acetyl co-A, Kreb cycle, Electron Transport System and Oxidative Phosphorylation, ATP, factors affecting respiration.

8. **Transport:** Plant water relationships, properties of water, diffusion, osmosis, imbibition, movement of water in flowering plants, uptake of water by roots, the ascent of water in xylem, apoplast symplast theory, Transpiration-structure of leaf and stomata in plants opening and closing mechanisim of stomata factors affecting transpiration, significance of transpiration General characteristics of blood vascular system, development of blood systems in animals, Composition of blood, circulation in blood vessels, formation of tissue fluids, the heart, functions of mammalian blood, the immune system.

Text / Reference Books:

LIFE. The Science of Biology. 8th edition, Sadava,,Heller, Orians, purves, Hills. 2008. *W.H.Freeman*.

BA-109 MATHEMATICS - I

1. **Differentiation:** Successive Differentiation, Leibnitz's theorem (without proof). Lagrange's Theorem, Cauchy mean value theorem, Taylor's theorem (without proof), Remainder Term, Asymptotes, Curvature, Curve Tracing
2. **Infinite Series:** Convergence, divergence, Comparison test, Ratio test, Cauchy's n^{th} root test test, Leibnitz's test (without proof), Absolute and Conditional Convergence. Taylor and Meclaurin series, Power series, Radius of convergence
3. **Integral Calculus:** Reduction Formulae of trignometric functions, Properties of definite Integral, Applications to length, area, volume, surface of revolution, Definition of improper integrals, Beta-Gamma functions.
4. **Calculus of Functions of Several Variables:** Partial derivatives, Chain rule, Differentiation of Implicit functions, exact differentials. Maxima, Minima and Saddle points. Method of Lagrange multipliers. Differentiation under integral sign. Jacobians and transformations of coordinates. Double and Triple integrals, Simple applications to areas, volumes etc

5. **Vector Calculus:** Scalar and vector fields. Curves, Arc length, Tangent, normal, Directional Derivative, Gradient of scalar field, divergence and curl of a vector field. Line integrals (independent of path), Green's theorem, Divergence theorem and Stoke's theorem (without proofs), Surface Integrals.

Text / Reference Books:

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic Geometry", 6^{th} edition, Addision Wesley/Narosa, 1985.
2. Shanti Narayan, "Differential Calculus", S. Chand & Co.
3. Shanti Narayan, "Integral Calculus", S.Chand & Co.
4. Grewal B.S., "Higher Engineering Mathematics", Khanna Publication.
5. E. Kreyszig, "Advanced Engineering Mathematics", 5^{th} Edition, Wiley Eastern, 1985.

BT-115 CONCEPTS IN BIOTECHNOLOGY

1. **Introduction to Biotechnology:** Definitions, Historical perspectives, Scope and importance, Commercial potential, An interdisciplinary challenge, A Quantitative approach, Classical vs. Modern concepts, Manufacturing quality control, Product safety, Good manufacturing practices, Good laboratory practices, Marketing, Biotechnology in India and Global trends
2. **Fundamentals of Biochemical Engineering -** Concept of pH, Buffer, Physical variables, dimensions and units, Measurement conventions, Physical and chemical property data, Stoichiometry, Errors in data and calculations, absolute and relative uncertainty, types of error, Statistical analysis, Presentation of experimental data, Data analysis, Trends, Testing mathematical models, goodness of Fit, Use of graph paper with Logarithmic Coordinates, General procedure for plotting data, Process flow diagrams, Material and energy balances, fluid flow and mixing, Heat transfer, Mass transfer, Unit operations, Homogeneous reactions, Heterogeneous reactions, Reactor engineering.
3. **Protein Structure and Engineering:** Introduction to the world of Proteins, 3-D Shape of Proteins, Structure Function relationship in Proteins, Purification of Proteins, Characterization of Proteins, Protein based products, Designing Proteins, Proteomics.
4. **Recombinant DNA Technology:** Introduction, Tools of rDNA Technology, Making Recombinant DNA, DNA Library, Introduction of Recombinant DNA into host cells, Identification of Recombinants, Polymerase Chain Reaction (PCR), DNA Probes, Hybridization Techniques, DNA Sequencing, Site-directed mutagenesis.
5. **Genomics and Bioinformatics:** Introduction, Genome Sequencing Projects, Gene prediction and Counting, Genome similarity, SNPs and comparative genomics, Functional Genomics, History of Bioinformatics, Sequences and Nomenclature, Information Sources, Analysis using Bioinformatics tools.
6. **Microbial Culture and Applications:** Introduction, Microbial Culture Techniques, Measurement and Kinetics of Microbial Growth, Scale up of Microbial Process, Isolation of Microbial Products, Strain Isolation and Improvement, Applications of Microbial Culture Technology, Bioethics in Microbial Technology.
7. **Plant Cell Culture and Application:** Introduction, Cell and Tissue Culture Techniques, Applications of Cell and Tissue Culture, Gene Transfer Methods in Plants, Transgenic Plants with Beneficial Traits, Diagnostics in Agriculture and Molecular Breeding, Bioethics in Plant Genetic Engineering.
8. **Animal Cell Culture and Applications:** Introduction, Animal Cell Culture Techniques, Characterization of Cell Lines, Scale-up of Animal Culture Process, Applications of Animal Cell Culture, Stem Cell Technology, Bioethics in Animal Genetic Engineering.
9. **Biotechnology and Society** - Public perception, Role of sciences, Engineering, Arts, Commerce, Patenting - Criterion for patents, Discovery vs Invention, Product and process patent, Reading a patent, National and International Patent Laws, Varietal protection, Patenting of biological systems, Ethical issues in agriculture and health care

Text / Reference Books:

1. A textbook of Biotechnology for Class XI and XII, CBSE.
2. Biotechnology by Smith, Cambridge Press.

IT – 105 INTRODUCTION TO COMPUTERS

1. **Introduction: Overview** of computer organization and historical perspective computer applications in various fields of science and management, Data representation: Number systems, character representation codes, Binary, hex, octal codes and their inter conversions. Binary arithmetic, floating point arithmetic, signed and unsigned numbers. Data storage: Primary and Secondary storage. Introduction to various computer devices such as keyboard, mouse, printers, disk files, floppies etc. Concept of computing, contemporary, Operating Systems such as DOS, Windows 95, UNIX etc. (only brief user level description). Introduction to organization and architecture of mainframe, mini and micro systems. Introduction to E-mail, ftp, login and other network services, worldwide web, MS-Office.

2. **Introduction to Programming:** Concept of algorithms, Flow charts, Example of Algorithms such as how to add ten numbers roots of a quadratic equation. Concept of sequentially following up the steps of the algorithm, Notion of program, programmability and programming languages. Structure of programs, object codes, compilers, Introduction to the Editing tools such as vi or MS-VC editors, Concepts of the finite storage, bits, bytes, kilo, mega and gigabytes. Concepts of character representation.

3. **Programming using C:** The emphasis should be more on programming techniques rather that the language itself. The C programming language is being chosen mainly because of the availability of the compilers, books and other reference materials, Example of some simple C program. Dissection of the program line by line. Concepts of variables, program statements and function calls from the library (print for example), C data types, int, char, float etc, C expressions, arithmetic operations, relational and logic operations, C assignment statements, extension of assignment to the operations. C primitive input output using getchar and putchar, exposure to the scanf and printf functions, C statements, conditional executing using if, else. Optionally switch and break statements may be mentioned, Concepts of loops, example of loops in C using for, while and do-while. Optionally continue may be mentioned, One dimensional arrays and example of iterative programs using arrays, 2-d arrays. Use in matrix computations, Concept of Sub-programming, functions. Example of functions. Argument passing mainly for the simple variables, Pointers, relationship between arrays and pointers. Argument passing using pointers. Array of pointers. Passing arrays as arguments, Strings and C string library, Structures and Unions. Defining C structures, passing strings as arguments. Programming examples, File I/O. use of fopen, fscanf and fprintf routines.

Text / Reference Books:

1. Fundamentals of Computers by V. Raja Raman.
2. 'C' Language by Brian Gottfried by Schaum Series.
3. Introduction to Computers by Leon & Leon.

BA-128 FOUNDATION COURSE IN PHYSICS - II

1. **Electricity and magnetism:** Electric fields, Gauss' Law, its integral and differential form, applications. Lorentz force, fields due to moving charges, the magnetic field, Ampere's law, motion of a charged particle in an electric and magnetic field, magnetic and electrostatic focussing, Hall effect, determination of e/m by cathode ray tube, positive rays, Thomson's parabolic method, Isotopes, Mass spectrographs (Aston and Bainbridge), Electron microscope, Cyclotron and Betatron.

2. **Quantum statistics:** The Statistical distributions: Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac statistics, their comparisons, Fermions and Bosons. Applications: Molecular speed and energies in an ideal gas. The Black-body spectrum and failure of calssical statistics to give the correct explanation - the application of Bose-Eientein statistics to the Black-body radiation spectrum, Fermi-Dirac distribution to free electron theory, electron specific heats, Fermi energy and average energy - its significance.

3. **Band theory of solids:** Origin of energy bands in solids, motion of electrons in a periodic potential- The Kronig-Penny model. Brillouin zones, effective mass Metals. semi-metals. semi-conductors and insulators and their energy band structure. Extrinsic and intrinsic semiconductors, doping - Fermi energy for doped and undoped semiconductors, the p-n junction (energy band diagrams with Fermi energy), the unbiased diode, forward and revesrse biased dides- its characteristics, tunnel diode, zener diode, photo-diode, LED, the photo-voltaic cell, the transistor, its characteristics, common base, common emmiter, common collector, load line, relation between α and β.

4. **Superconductivity:** Introduction to superconductivity, the Meissner effect, Type I and II superconductors, the Josephson effect, flux quantization, Cooper pais, the BCS theory (qualitative), properties and applications of superconductors.

Text / Reference Books:

1. Modern Physics by A. Beiser.
2. Optics by A.K. Ghetak
3. Modern Physics by Hallday & Resvik.
4. Introduction to Physical Optics by Jenkin & White

BA – 108 MATHEMATICS - II

1. **Linear Algebra:** Linear Independence and dependence of vectors, Systems of linear equations-consistency and inconsistency. Gauss elimination method, rank of a matrix, Bilinear, Quadratic, Hermitian, Skew-Hermitian Forms, Eigenvalues and Eigenvectors of a matrix, diagonalization of a matrix, Cayley-Hamilton Theorem (without proof).
2. **Ordinary Differential Equations**: Formation of ODE's, definition of order, degree and solutions. ODE's of first order : Method of separation of variables, homogeneous and nonhomogeneous equations, exactness and integrating factors, linear equations and Bernoulli equations. General linear ODE's of nth order : solutions of homogenous and nonhomogenous equations, operator method, method of undetermined coefficients and variation of parameters. Solutions of simple simultaneous ODE's. Power series method of solution of DE, Legendre's Equation, Legendre's Polynomials, Bessel's equation, Bessel's function.
3. **Complex Variables**: Curves and Regions in the Complex Plane, Complex Functions, Limits, Derivative, Analytic Function, Cauchy-Riemann Equations, Laplace's Equation, Linear Fractional Transformations, Conformal Mapping, Complex Line Integral, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Function, Power Series, Taylor Series, Laurent Series, Methods for obtaining Power Series, Analyticity at Infinity, Zeroes, Singularities, Residues, Residue Theorem, Evaluation of Real Integrals.
4. **Probability:** Definition of Sample Space, Event, Event Space, Conditional Probability, Additive and Multiplicative law of Probability, Baye's Law theorem, Application based on these results.

Text / Reference Books:

1. N.M. Kapoor "Differential Equations" Pitamber Pub. Co.
2. Schaum Outline Series "Differential Equations" Mc. Graw Hill.
3. Schaum Outline Series "Complex Variables" Mc. Graw Hill.
4. Schaum Outline Series "Linear Algebra" Mc. Graw Hill.
5. Schaum Outline Series "Probability" Mc. Graw Hill.

BA-132 FOUNDATION COURSE IN ORGANIC CHEMISTRY - II

1. **Reactive intermediates**- Generation, structure and general reactions of carbocations, carbanions, free radicals and carbenes (singlet and triplet). Wagner-Meerwein rearrangement, Electrophiles and nucleophiles, concepts of acids and bases. Bronsted theory, Lewis theory 1 and Person's Classification (HSAB), Carbon acids (active methyiene groups), super acids, Correlation of structure with acidity and basicity. Hyperconjugation : concept and consequences. Field effect, Resonance effect - Resonance energy and its significance, (vertical and empirical resonance energy), Strains in acyclic compounds.
2. **IUPAC Nomenclature**: Systematic IUPAC nomenclature of different classes of compounds including aromatic, bicyclic, and spiro compounds and polyfunctional compounds.
3. **Stereochemistry**: Classification of stereomers, diastereoiners, Separation of enantiomers. Absolute configuration (R and S), Projection formulae. Stereochemistry of compounds containing two asymmetric C-atoms. Elements of symmetry - centre, plane, axis of symmetry, Stereochemistry of biphenyls and spiro compounds, Conformations: Conformations around a C-C bond in acyclic compounds, Structure of cycloalkanes, different. Strain in cyclic compounds, Cyclohexane conformations, Stereochemistry of disubstituted cyclohexanes. Geometrical isomerism- Concept, E and Z nomenclature, Stereoselective and specific Reactions. Introduction to asymmetric synthesis. Bonds weaker than covalent bond: Hydrogen bonding - nature, types, stability and effects, van der Waals forces, Electron-donor acceptor complexes. Inclusion compounds.
4. **pΠ - dΠ bonding** in organic compounds, ylids (S and P), Wittig reaction.
5. **Automatism**: Cationotropy and anionotropy, Prototropic shifts in different systems, ring-chain tautomerism and valence tautomerism, Cope rearrangement.
6. **Alkenes**: Methods of preparation, Source-petroleum and coal in brief, Cracking and reforming.
7. **Alkenes**: Methods of preparation. Reactions: Hydrogenation, oxidation, hydroxylation, addition-Markownikoff rule with explanation and peroxide effect. Dienes - types of dienes and their characteristic reactions, effect of conjugation on stability and reactivity, Diels-alder reaction in detail with its stereochemistry. Polymerisation of olefinic compounds, Use and mechanism of Ziegler-Natta catalysts, Hydroboration reaction, Claisen rearrangement.

Text / Reference Books:

1. Modern Organic Chemistry by D.R. Boyed.
2. Organic Chemistry by I.L. Finar.
3. Organic Chemistry Reaction Mechanism by Jerry March.

BA – 122 LIFE SCIENCES - II

1. **Coordination and control:** Plant movements (Tactic, Tropic, Nastic), plant growth substances (Auxins, Cytokinins, Gibberellins, ABA, Ethylene), phytochrome and effect of light on plant development, vernalisation and flowering. Nervous system, parts of the nervous system, sensory receptors, structure and function of receptors, Endocrine system, role of hormones in growth and development of humans.

2. **Homeostasis:** Control system in biology, control of blood glucose level, temperature regulation in endothermic animals, the liver and its importance.

3. **Mendalian Analysis:** Experiments of Mendel, Simple mendalian genetics in humans, in agriculture, Variants and genetic dissection.

4. **Asexual Reproduction:** Apomixis, and other means of natural vegetative reproduction (Bulb, corm, rhizome, stolon, runner, tuber, tap roots, tillers), advantages and disadvantages of natural asexual reproduction. Artificial propagation - cutting, grafting, budding, layering, micropropagaion through tissue culture, advantages and disadvantages of micropropagation.

5. **Sexual reproduction:** Life cycle of flowering plants, the parts of a flower (Dicot and monocot), microsporogenesis, in-vitro pollen culture, microgametogenesis, isolation of sperms, palynology, scope of palynology, development of ovule, types of ovule, megasporogenesis, megagametogenesis, embryosac, function of different cells of embryosac, pollination types of pollination, pollen-pistil interaction, self incompatibility, fertilization, double fertilization, post fertilization changes in ovule and embryo, seed formation, structure of seed and its importance.
   Review of sexual reproduction in vertebrates, human intervention in reproduction.

6. **Continuity of life:** Chromosome, cell cycle, mitosis and meiosis, techniques to study mitosis and meiosis.

7. **Heredity and Variation:** Mendel's work, chromosomal basis of inheritance, modified dihybrid ratios, gene interaction, linkage, gene mapping, sex determination, cytoplasmic inheritance, variation and mutation.

8. **Economically Important Plants :** Classification systems, Important families (Fabaceae, Poaceae, Malvaceae, Cucurbitceae, Crucifereae, Leguminoseae), Cereals (wheat, rice maize), Beverages (tea, coffee, cocoa), Fibers (jute, linen, cotton), wood (pines, cedar, teak, sisham), rubber (para rubber), spices (turmeric, black pepper, cloves, coriander), medicinal plants (Ephedra, Taxus, Cinchona, Fox glove, Belladonna, Rauvolfia, Neem, Hemp.)

Text / Reference Books:

LIFE: The Science of Biology, 8th Edition, Sadava, Heller, Orians, Purves, *Hill* 2008

BT–124 LABORATORY TECHNIQUES IN BIOTECHNOLOGY

1. **pH, Buffers**: Principles and theory, pH meters.
2. **Colorimetry & Spectroscopy:** Basic principles, nature of electromagnetic radiation, Beer-Lambert laws, colorimetric methods & instruments, principles of spectroscopy, types of spectra-absorbance, emission, fluorescence and action spectra, single and double beam spectrophotometers, densitometers, flame photometer, fluorimeters, circular dichorism & their applications.
3. **Cell separation and flow cytometry**, magnetic beads and elutriator.
4. **Microscopy**: Basic principles, instrumentation, sample preparation for optical, phasecontrast, interference, polarization, inverted fluorescence, confocal & electron microscopes & their applications.
5. **Microtomy:** Principles & types, sample preparation & sectioning parameters.
6. **Centrifugation:** Principles & types simple & differential, ultracentrifugation-preparative & analytical.
7. **Chromatography:** Principles, methodology and applications of chromatography using paper, thin layer, column (gel filtration, ion exchange, affinity), gas, HPCL, FPCL etc.
8. **Electrophoresis**: Principles and types of electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse-filed gel electrophoresis; gel matrices: polyacrylamide, agarose etc. critical parameters for optimum separation and resolution, two dimensional electrophoresis (IEF).
9. **Radioisotope methods and tracer techniques in biology:** Basic principles of radioactivity, properties & handling of radioisotopes in biology & medicine, radiation units, Geiger Muller & scintillation counters, autoradiography, radionucleide imaging, CT scan.
10. **Biophysical Techniques:** X-ray crystallography Nuclear Magnetic Resonance (NMR) spectra, magnetic Resonance Imaging (MRI), lasers in biology and medicine, Mass spectrometry.

Text / Reference Books:

1. Biochemical Calculations by Irwin H. Segel, John Wiley & Sons (2nd Edition), 1975

IT – 120 ELECTRICAL SCIENCE

1. **Properties of Conductors and Insulators :** Basic laws of Electrical Engineering, Temperature Resistance Coefficients

2. **D. C. Circuits :** Network theorems and applications, Division of Current, Potentiometer, Circuit parameters, Energy and power, Superposition, Thevenin and Reciprocity theorems, Star Delta Formations

3. **Alternating Currents :** Peak, Average and RMS values for alternating currents, Power and Power factor , Resistance, Inductance and Capacitance, Resonance, Q Factor.

4. **Measuring Instruments :** Electromagnetism, Moving Coli and Moving Iron, Instruments, Construction Instruments, Attraction and Repulsion type, Permanent Magnet and Eletrodynamics, Dynamometer type.

5. **D. C. Generators & Motors :** Principle of operation of Generators & Motors, Speed Control of shunt motors, Flux control, Rheostatic control, voltage control, Speed control of series motors.

6. **A. C. Generators & Motors :** Principle of operation, Revolving Magnetic field, Squirrel cage and phase wound rotor, Starting of Induction motors, Direct on line and Star Delta starters, Synchronous machines.

7. **Transformers:** Construction, Regulation and efficiency calculations, Open and short circuit tests.

Text / Reference Books:

1. Electrical Engineering Fundamentals by Vincent DEL TURU. HUGHES, Electrical Technology.

BT-201 MICROBIOLOGY

1. **Microbes in our lives:** Types of microorganisms. Brief history of microbiology. Microbes & human warfare. Microbes & human disease.

2. **Observing Microorganisms through a Microscope:** Light, electron, scanned-probe microscopy. Simple, differential and special stains.

3. **Functional Anatomy of Prokaryotic and Eukaryotic Cells:** Size, shape, and arrangement of bacterial cells. Structures external to cell wall, structures internal to cell wall. Microbial Metabolism.

4. **Catabolic & anabolic reactions:** enzymes, energy production and carbohydrate metabolism. Lipid & protein catabolism, bacterial identification and photosynthesis. Energy production mechanism, metabolic diversity & pathways of energy use. Integration of metabolism.

5. **Microbial Growth:** Growth requirements, culture media, obtaining pure cultures and preservation of cultures, growth of bacterial cultures, Control of Microbial Growth, Action of microbial control agents, physical and chemical methods of microbial control.

6. **A survey of the Microbial World:** Classification of microorganism and methods of classifying and identification of microorganism.

7. **The prokaryotes groups:** domain bacteria, proteobacteria, nonproteobacteria Gram-ve and Gram+ve bacteria. Bacterial diversity.

8. **Fungi**, lichens, algae, protozoa, helminthes, arthropods as vectors.

9. **Viruses:** viral structures, isolation, cultivation and identification of viruses, viral multiplication.

10. **Principles of disease and epidemiology:** Mechanism of microbial pathogenicity.

11. **Antimicrobial Drugs**. History, spectrum and action of antimicrobial drugs. Tests to guide chemotherapy and effectiveness of chemotherapeutic agents.

12. **Applied & Industrial Microbiology:** Industrial fermentation, primary and secondary metabolites, Role of microorganisms in the production of industrial chemicals and pharmaceuticals, Microbes as alternative energy sources and as industrial products.

Text / Reference Books:

1. Microbiology: An Introduction: Tortora, Funke & Case. 7th edition, 2001
2. Microbiology: Davis, Dulbecco, Eisen and Ginsburg.
3. Introduction to Microbiology: Ross
4. General Microbiology: Stainier, Adelberq and Ingraham.

BA-203 BIOENERGETICS - I

1. **Biochemical Evolution:** Chemogeny, Biogeny, and Evolution of Chromosome Organization and Genetic Regulatory Mechanisms, Time factors in evolution, Evolution of Enzyme Systems.

2. **Amino Acids and Peptides:** Structure, Function, Methods of Characterization, Separation Techniques based on their structure and properties, Clinical Significance, Biosynthesis.

3. **Carbohydrates:** Mono and Polysaccharide, Classification, Structure, Function, Separation and Characterization Techniques, Clinical significance, Biosynthesis.

4. **Lipids:** Classification, Structure, Function, Separation and Characterization Techniques, Clinical Significance.

5. **Nucleic Acids:** Nucleic Acids and Polynucleotides, Classification, Structure, Function, Separation and Characterization Techniques, Clinical Significance.

6. **Vitamins and Micro and Macro Nutrients:** classification, Structure, Function, Separation and Characterization Techniques, Clinical Significance.

7. **Biochemical Energetics:** Energy Yielding and Energy Requiring Reactions, Calculations of Equilibrium Concentrations, Oxidation-Reduction Reactions, Metabolism and ATP Yield. Photosynthetic Phosphorylation, Active Transport, Second Law of Thermodynamics, Enthalpy and Entropy, Activation Energy.

8. **Spectrophotometry and other Optical methods:** Spectrophotometry, Flurometry, Optical Rotation - Polarimetry, Photochemistry, and Quantum efficiency.

Text / Reference Books:

1. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
2. Biochemistry by Lehninger. McMillan publishers
3. Biochemistry by Zubey. Wm. C. Brown publishers

BT- 205 CELL BIOLOGY

1. **The Cell:** a macromolecular assembly, cellular compartmentalization, organeller architecture.
2. **The Nucleus:** Chromosomal DNA and its Packaging, the Global Structure of Chromosomes, Chromosome Replication, RNA Synthesis and RNA Processing, the Organization and Evolution of the Nuclear Genome.
3. **Cytoskeleton:** The Nature of the Cytoskeleton, Intermediate Filaments, Microtubules, Cilia and Centrioles, Actin Filaments, Actin-binding Proteins, Muscle.
4. **Cell Junctions, Cell Adhesion, and the Extracellular Matrix :** Cell Junctions, Cell-Cell Adhesion, The Extracellular Matrix of Animals, Extracellular Matrix Receptors on Animal Cells- the Integrins, The Plant Cell Wall
5. **Membrane Structure, Transport of Molecules and Membrane Excitability:** The Lipid Bilayer, Membrane Proteins, Principles of Membrane Transport, Carrier Proteins and Active Membrane Transport, Ion channels and Electrical Properties of Membranes
6. **Protein Sorting and Vesicular Trafficking in the Cell:** The Compartmentalization of Higher Cells, The Transport of Molecules into and out of the Nucleus, The Transport of Proteins into Mitochondria and Chloroplasts, Peroxisomes, The endoplasmic reticulum.**,** Transport from the ER through the Golgi Apparatus, Transport from the Trans Golgi Network to Lysosomes, Transport from the Plasma Membrane via Endosome: Endocytosis, The Molecular Mechanisms of Vesicular Transport and the Maintenance of Compartmental Diversity.
7. **Cell Signaling:** General Principles of Cell Signaling, Signaling via G-Protein-linked Cell-Surface Receptors, Signaling via Enzyme-linked Cell-Surface Receptors, Kinase Receptors, Structural Features of Trans-membrane Receptors, Hormone Receptor Interaction, Two-component signaling, Second messengers.
8. **Cell Cycle and Division:** The General Strategy of the cell Cycle, The Mechanics of Cell Division, The Early Embryonic Cell Cycle, Cell- Cycle control in Yeasts and Multicellular Animals.
9. **Cancer:** Cancer as a Microevolutionary Process, Tumor cells, Proto-oncogenes and viral oncogenes, Tumor suppessor genes.

Text / Reference Books:

1. Molecular Biology of Cell by Albert et.al. John Wiley & Sons
2. The Cell by Cooper. ASM Press
3. Cell and Molecular Biology by Karp. John Wiley & Sons

BT-209 GENETICS

1. **Genetics and Organism:** Genetics and human affairs, Genetics and Biology, Genes and Environment, Techniques of genetic analysis.

2. **Chromosome Theory of Inheritance:** The chromosome theory of heredity, Sex chromosomes, Sex linkage, the parallel behaviour of autosomal genes and chromosomes.

3. **Mendelian Analysis:** Mendel's laws of inheritance, Interaction of genes, Variations on dominance, Multiple alleles, Lethal alleles, Several genes affecting the same character, Penetrance and expressivity,

4. **Linkage:** Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Three point testcross, Interference, Calculating recombinant frequencies from selfed dihybrids, examples of linkage maps, The X^2 test mitotic segregation in humans.

5. **Fine Structure of Genes:** The concept of promoter, Coding sequence, Terminator, Induction of gene for expression.

6. **Recombination in Bacteria and Viruses:** Conjugation recombination and mapping the E. coli chromosomes, Transformation, Transduction, Chromosome mapping.

7. **Biochemical Genetics:** Inborn errors of metabolism, one gene – one enzyme hypothesis, one gene – one protein, one gene – one polypeptide, colinearity

8. **The Extranuclear Genome:** The concept of extranuclear genome in higher plants and animals, Overview of mitrechondrial genome, Chloroplast genome.

9. **Population Genetics:** Darwin's revolution, Variation and its modulation, The effect of sexual reproduction on variation, The sources of variation, Selection quantitative genetics

10. **Principles of Plant Breeding**: Objectives, Selfing and crossing techniques, Male sterility, Incompatability, Hybrid vigour

11. **Human Genome Project:** Genetic diseases in humans, Genetics and society.

Text/ References books:

1. In Introduction to genetic analysis, Griffiths, Miller, Suzuki, Lewontin and Gelbart, Freeman and Company.
2. Genetics, A.V.S.S. Sambamurty, Narosa Publishing House.
3. Concepts of Genetics, Klug & Cummings, Prientice Hall.
4. Molecular Cloning, Moniatisetal, Cold Spring Harbor Laboratory.

BT-211 BIOSTATISTICS

1. Presentation of Data: Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves.
2. Measure of Location and Dispersion: Mean, Medium, Mode and their simple properties (without derivation) and calculation of median by graphs: range, mean deviation, Standard deviation, Coefficient of variation.
3. Probability and Distribution: Random distributions, events-exhaustive, mutually exclusive and equally likely, definition of probability (with simple exercises), definition of binomial, Poisson and normal distributions and their inter-relations, Simple properties of the above distributions (without derivation).
4. Correlation and Regression: Bivariate data – simple correlation and regression coefficients and their relation, Limits of correlation coefficient, Effect of change of origin and scale on correlation coefficient, linear regression and equations of line of regression, Association and independence of attributes.
5. Sampling: Concept of population and sample, Random sample, Methods of taking a simple random sample.
6. Tests of Significance: Sampling distribution of mean and standard error, Large sample tests (test for an assumed mean and equality of two population means with known S.D.); small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, T-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples.
7. Experimental Designs: Principles of experimental designs, Completely randomized, Randomized block and latin square designs, Simple factorial experiments of 22, 23, 24 and 32 types, Confounding in factorial experiments (mathematical derivations not required); Analysis of variance (ANOVA) and its use in the analysis of RBD.

Text/ References books:

1. Statistical methods in biology by Norman T.J. Bailey (3rd Edition), Cambridge University Press (1995).

CT-211 CHEMICAL ENGINEERING - I

1. Chemical engineering discipline, structure and practice.

2. Stoichiometry and chemical equations. Units, dimensions and conversions. Phase rule, Henry's law, Rault's law and their applications to gas-liquid and vapor-liquid systems.

3. Material balance for non-reacting and reacting systems, recycle and by pass.

4. Heats of solution, mixing and reactions. Types of energy and first law of thermodynamics.

5. Energy balance for non-reacting and reacting systems. Calculation of flame temperature and adiabatic reaction temperature.

6. Properties of fluids & fluid statistics. Mechanical energy balance.

7. Flow of incompressible fluids: laminar and turbulent flows, velocity distribution in pipes, pressure drop in pipes and fittings.

8. Stokes law and its applications.

9. Flow in packed beds.

10. Flow measurement: Orifice & Venturi meter. Pumps and their characteristics.

Text / Reference Books:

1. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P., McGraw Hill International Edition, Singapore, 5th Ed., 1993.
2. Chemical Engineering, Vol. 1, Coulson J.M. and Richardson J.F., Butterworth Heinemann, Oxford 6th Ed., 1999
3. Fluid Mechanics, Douglas J.F., Gasiorek J.M., Swaffield J.A., Addison-Wesley Longman, 3rd Ed., 1995.
4. Basic Principles of Calculations in Chemical Engineering, Himmelblau D.M., Prentice Hall, 6th Ed., 1999.
5. Elementary Prnciples of Chemical Processes, Felder R.M. and Rousseau R.W., John Wiley & sons, Inc., 3rd Ed., 2000.

BT-202 IMMUNOLOGY

1. **Introduction to Immunology:** Properties of immune response, Innate and acquired immunity, active and passive immunity.

2. **Cells & Tissues of Immune System:** Lymphocytes, Classes of lymphocytes, antigen presenting cells, NK Cells, Mast Cells, Dendritic Cell, Organs of the Immune System, Bone marrow, Thymus, Lymph node, Spleen, CALT, MALT.

3. **Molecular Immunology**: - Molecular structure of antibody, Classification, Isotypes, Synthesis assembly and expression of immunoglobulin molecules, Nature of antigens, function and diversity, Generation of anti-body diversity.

4. **Antigens:** Different characteristics of antigens, mitogens, Hapten, Immunogen, Adjuvants.

5. **MHC**: Discovery of MHC complex, Role of MHC, Structure of MHC molecule, binding of peptides to MHC molecules, MHC restriction.

6. **Effecter Mechanism of Immune Response:** Cytokines, T- cell receptors, cell activation, complement system, antigen processing and presentation, regulation of immune response.

7. **Immunological Techniques**:- antigen- antibody reactions, Immuno diffusion, immunoelectro-phoresis, ELISA, RIA, fluorescence activated cell sorter,

8. **Applied Immunology**:- Immune system in health and disease, autoimmunity, hyper-sensitivity, tumor immunity, tissue and organ transplant, Synthetic vaccines.

9. **Hybridoma technology**: - Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their application.

Text / Reference books:

1. Kuby- Immunology (4th Edition) by R. A. Goldsby, T.J. Kindt, B.A. Osborne.
2. Essentials of Immunology (6th Edition): Ivan Riot- Blakswell Scientific Publications, Oxford, 1988.
3. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988.
4. Antibodies A laboratory Manual: Harlow and David Lane (1988), Cold spring harbor laboratory.

BT-204 MOLECULAR BIOLOGY

1. **Structure and properties of nucleic acids:** Models of DNA structure; RNA structure; Physical, Chemical, Spectroscopic Nuclear & Organelle genomes,
2. **Genome Complexity:** L C value paradox, cot analysis, Repetitive DNA, Satellite DNA, Pseudo genes, Synteny.
3. **Chromosome organization:** Histones, Non-histones, Nucleosome, Chromatin, Chromosome structure in prokaryotes & eukaryotes,
4. **Gene organization:** Split Genes, Overlapping genes, Transposons & Retrotransposons, Gene clusters,
5. **DNA-Protein interaction:** DNA- binding motifs, Methods of studying DNA – binding proteins,
6. **DNA Replication:** Models of DNA replication, Enzymology of DNA replication, The Replication process, Initiation, Elongation & Termination of replication; Telomeres.
7. **Transcription and mRNA processing:** Components of transcriptional machinery in prokaryotes and eukaryotes; Initiation, Elongation & Termination of transcription; Capping, Polyadenylation, Splicing, mRNA stability.
8. **Translation:** The Genetic code; tRNA & aminoacyl synthetases, Ribosomes, Translation process, Initiation, Elongation & termination of transcription; Capping, Polyadenylation, Splicing, mRNA stability.
9. **Regulation of gene expression:** General aspects of regulation prokaryotes & eukaryotes; the operm model, lac & trp operons; DNA methylation; Tissue-sp. & developmental stage sp. Expression of genes.
12. **Gene Mutation:** Somatic vs germinal mutation, Mutant types, Selective Systems, Induction of mutation, Chromosomal mutations, Changes in chromosome structure mutation and cancer, Mutagens in genetic dissection, Mutation breedings, Molecular basis of gene mutations, Repair defects and human diseases, Recombination, Transposable genetic elements.
10. **Molecular evolution:** DNA based phylogenetic trees and their applications.

Text / Reference Books:

1. Gene VII by B. Lewin.
2. Essentials of molecular Biology, Malacinski and Freifelder Jones and Bartlelt Publishers.
3. Genomes, T. A. Brown, John Wiley and Sons PTE Ltd.
4. Cell and molecular Biology, Concepts and experiments Gerald Karp, John Wiley and Sons.
5. The Cell - A molecular approach, Gm Cooper Asm Press.

BT-206 ENZYME TECHNOLOGY

1. **Introduction to enzymes:** What are enzymes, brief history of enzymes, nomenclature and classification of enzymes?

2. **Structural Features of Enzymes**: Chemical nature of Enzymes: amino acids, the building blocks of protein, Levels of protein Structure: Primary, secondary, tertiary and quaternary structure.

3. **Specificity of Enzymes**: Types of specificity, the Koshland "induced fit" hypothesis, Strain or transition – state stabilization hypothesis.

4. **Enzyme Catalysis and Kinetics**: Factors affecting the rate of chemical reactions, kinetics of uncatalyzed chemical reactions, kinetics of enzyme-catalyzed reaction, methods for investigating the kinetics of enzyme-catalyzed reactions, nature of enzyme catalysis, inhibition of enzyme activity.

5. **The Investigation of Active Site Structure and Chemical nature of Enzyme Catalysis:** The identification of binding sites and catalytic site, three dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal-activated enzyme and metalloenzyme, coenzymes in enzyme catalyzed reactions.

6. **Immobilization of Enzymes**: Concept, methods of immobilization, Kinetics of immobilized enzymes, effect of solute partition and diffusion on kinetics of immobilized enzymes, use of immobilized enzymes, bioreactors using immobilized enzyme.

7. **Industrial uses of enzymes**: Industrial enzymes: Sales value of industrial enzymes, traditional (non-recombinant) sources of industrial enzymes, The impact of genetic engineering on enzyme production, Engineered enzymes, Extremophiles: hyperthermophiles, enzymes from hyperthermophiles, enzymes from additional extremophiles, enzymes in organic solvent

8. **Industrial enzymes: proteases and carbohydrases:** Proteolytic enzymes: Carbohydrases, Lignocellulose degrading enzymes, Pectin and pectic enzymes.

9. **Additional industrial enzymes:** Lipases, Penicillin acylase, Amino acylase and amino acid production, cyclodextrins and cyclodextrin glycosyl transferase, enzymes in animal nutrition, Oxidoreductases, Enzymes in molecular biology.

10. **Enzyme Engineering**: Prediction of enzyme structure, design and construction of novel enzymes.

Text / Reference Books:

1. Enzymes by Palmer (2001): Horwood Publishing Series.
2. Fundamentals of Enzymology by Price and Stevens (2002): Oxford University Press.
3. Enzyme Technology by Helmut uhling (1998): John Wiley
4. Introduction to Proteins Structure by Branden and Tooze (1998): Garland Publishing Group.

BA - 208 BIOENERGETICS – II

1. **Catabolism and the Generation of Chemical Energy**

2. **Metabolic Strategies:** General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis

3. **Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway:** Glycolysis, Gluconeogenesis, Regulation of glycolysis and Gluconeogenesis, The pentose Phosphate Pathway

4. **The Tricarboxylic Acid Cycle:** Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereochemical Aspects of TCA Cycle Reactions, ATP Stoichiometry of the TCA Cycle, Thermodynamics of the TCA Cycle, The Amphibolic Nature of the TCA Cycle, The Glyoxylate Cycle, Oxidation of other Substrates by the TCA Cycle, Regulation of TCA Cycle Activity

5. **Electron Transport and Oxidative Phosphorylation:** The Mitochondria Electron - Transport Chain, Oxidative Phosphorylation, Transport of Substrates, Pi, ADP and ATP into and out of Mitochondria, Electron Transport and ATP Synthesis in Bacteria,

6. **Photosynthesis and other Processes Involving Light :** Photosynthesis, Other Biochemical Processes Involving Light

7. **Metabolism of Fatty Acids:** Fatty Acid Degradation, Biosynthesis of Saturated Fatty Acids, Regulation of Fatty Acid Metabolism

Text / Reference Books:

1. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
2. Biochemistry by Lehninger. McMillan publishers
3. Biochemistry by Zubey. Wm. C. Brown publishers

CT-212 CHEMICAL ENGINEERING-II

1. **Mixing:** types of agitators, flow patterns and power consumption.

2. **Steady state conduction:** Fourier's law, concept of resistance to heat transfer, critical insulation thickness, conduction with heat generation.

3. **Convection:** Film theory and concept of heat transfer coefficient. Heat transfer in laminar and turbulent flows.

4. **Heat Exchanger:** sizing of shell & tube heat exchangers. Heat transfer in agitated vessels.

5. **Boiling & Condensation:** heat transfer to boiling liquids and from condensing vapours.

6. **Fundamentals of mass transfer**: moleuclar diffusion in fluids and solids, concept of mass transfer coefficient. Equilirbium stage, multistage and contious contactors with applications to gas absoption, calculation of NTU, HTU and number of stages.

7. Psychrometric chart and its applications.

Text / Reference Books:

1. Transport Processes and Unit Operations, Geankoplis C.J., Prentice Hall of India, 3rd, 1999.
2. Heat Transfer, Holman J.P., McGraw Hill, New York, 8th Ed 1997.
3. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore, 5th Ed., 1993.
4. Chemical Engineering, Vol. I and II, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford, 6th Ed., 1999.

BT-301 PLANT TISSUE CULTURE

1. **History:** Important events in the history of plant tissue culture.

2. **Laboratory Requirements and General Techniques:** Introduction, requirements, techniques.

3. **Cellular Totepotency:** Introduction, cyto-differentiation, orgemogenic differentiation, loss of morphogenic potential in long-term cultures, practical applications of cellular totipotency

4. **Tissue Culture Media:** Introduction, media constituents, media selection, media preparation

5. **Cell and Suspension Culture:** Introduction, isolation of single cells, suspension cultures, culture of single cells, plant cell reactors, applications of cell culture.

6. **Protoplast Culture:** Protoplast isolation, culture and regeneration.

7. **Somatic Embryogenesis**: Introduction, some examples of formatic embryogenesis, factors affecting somatic embryogenesis, induction and development, maturation

8. **Haploid Production:** Introduction, techniques, factor affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos, gynogeresis, haploid production through disport hybridization idiptridization to raise homozygous diploids, applications, limitations.

9. **Triploid Production:** Introduction, callusing, histology and cytology of cells, organogenesis, applications of endosperm culture.

10. **Embryo Culture:** Introduction, techniques, culture requirements role of the suspensor in embryo culture, precocious germination, morphogenesis in the culture of seeds with partially differentiated embryos, micronugical experiments, embryo and seed culture of parasitic angiosperms, morphogenic potential of the embryo callus, practial applications.

11. **In-vitro pollination and fertilization:** Introduction, terminology, in vitro pollination, in vitro fertilization, applications.

12. **Micropropagation:** Introduction, techniques, applications, production of pathogen free plants

13. **Production of secondary metabolites:** Introduction, strategies used to optimize product yield, commercial aspects

14. **Germplasm Storage:** Introduction, long-term storages, short or medium term storage

Text / Reference Books:

1. Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.
2. Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996) Elsevier, Amsterdam.
3. An Introduction to Plant Biotechnology by H C Chawla Oxford and IBH 2002

BT-303 MICROBIAL PROCESS ENGINEERING

1. **Bio Process Development**: An interdisciplinary challenge, major classes of products

2. **Introduction to Engineering calculation, presentations and analysis of data:** Physical variables, dimensions, units, errors in data and calculations, testing mathematical models, process flow diagram.

3. **Material Balances:** Thermodynamics Law of conservation of mass, types of material balance products, electron balances, biomass yield, theoretical oxygen demand., problems

4. **Energy Balances:** Basic concepts, General Energy balance equations, Enthalpy calculations, Enthalpy changes in non-reactive processes, Types of energy balance calculations, Types of heat reactions, problems

5. **Unsteady state material and energy balances:** Material balance equation for CSTR, Energy balance equations, solving differential equations, solving mass balances, solving energy balances, problems

6. **Fluid flow and mixing:** Classification of fluids, Reynolds number, Momentum transfer, Non – Newtonian fluids, Two-Parameter models, rheological properties of fermentation broths, mixing, power requirements for mixing, scale-up of mixing systems, role of shear in stirred fermentors, problems

7. **Heat transfer:** Equipments, mechanism of heat transfer, conduction, heat transfer between fluids, design equation for heat transfer systems, applications of design equations, problems

8. **Mass transfer:** Molecular diffusion, role of diffusion in bioprocessing, film theory, convective mass transfer, oxygen uptake and transfer in cell cultures, kLa determination, problems.

9. **Homogeneous reactions:** Basic reaction theory, calculation of reaction rates, general reaction kinetics for biological systems, yields in cell culture, cell growth kinetics, production kinetics, kinetics of cell death, problems

10. **Heterogeneous reactions:**Concentration gradients and reaction rates in solid catalysts, internal mass transfer and reaction, the Thiele modulous and effectiveness factor, external mass transfer, problems

11. **Reactor Engineering:** Bioreactor configurations, practical considerations for bioreactor construction, monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor, case study of penicillin production.

Text / Reference Books:

1. Bioprocess Engineering - Basic concepts by M. L. Schuler & F. Kargi, Entice Hall 1992.
2. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press 1995.
3. Fermentation & Biochemical Engineering Hand Book (1983), Principles, Process Design and Equipment. HC Vogel, Noyes.
4. Principal of Microbe & Cell Cultivation (1975), SJ Prit, Blackwell Scientific co.).
5. Bioprocess Computations in Biotechnology (Vol. 1) TK Ghose, Ellis Howard Ltd.

BT-305 Animal Biotechnology

1. **Introduction to Animal Tissue Culture:** Background, Advantages, Limitations, Application, Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation.

2. **Design, Layout and Equipment:** Planning, Construction, Layout, Essential Equipments, Aseptic Technique, Objectives, Elements, Sterile Handling, Safety, Risk Assessment, General Safety, Fire, Radiation, Biohazards

3. **Media:** Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media

4. **Primary Culture:** Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance

5. **Characterization & Quantitation of Cell Line:** Need for characterization, Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Transformation, Immortalization, Aberrant Growth Control, Tumorigenicity, Cell counting, DNA content, Protein, Rates of Synthesis, Cell Proliferation, Plating Efficiency, Labeling Index, Generation Time.

6. **Contamination:** Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination

7. **Cryopreservation:** Need of Cryopreservation, Preservation, Cell banks, Transporting cells

8. **Cytotoxicity:** Introduction, In vitro limitations, Nature of assay, Viability assay, Survival assay, Microtitration assay, Transformation assay

9. **Transgenic Animals:** Methodology, Embryonic Stem Cell method, Microinjection method, retroviral vector method, Applications of transgenic animals

10. **Gene Therapy:** Ex-vivo gene therapy, In vivo gene therapy, Viral gene delivery system, Retrovirus vector system, Adenovirus vector system, Adeno-Associated virus vector system, Herpex simplex virus vector system, Non-viral gene delivery system, Prodrug activation therapy, Nucleic acid therapeutic agents

11. **In Vitro Fertilization and Embryo Transfer:** Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA

Text / Reference Books:

1. Animal Cell Culture by John R.W. Masters
   Oxford University Press
2. Introduction to Cell and Tissue Culture by Jennie P. Mather and Penelope E. Roberts
   Plenum Press, New York and London
3. Molecular Biotechnology: Primrose.
4. Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.

BT-307 RECOMBINANT DNA TECHNOLOGY & APPLICATION

1. Basic concepts in genetic engineering

2. **Tools of Genetic Engineering:** Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc.

3. **Cloning Vectors:** Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, virus-based vectors.

4. **Methods of gene transfer:** Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agrobacterium mediated gene transfer.

5. **Preparation and application of molecular probes:** DNA probes, RNA probes, Radioactive labeling, Non-radioactive labeling, use of molecular probes, DNA fingerprinting.

6. **Analysis and expression of cloned gene in host cells:** Expression vectors, Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, and Fusion proteins.

7. **Gene libraries** - cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, identifying the products of cDNA clones.

8. **Isolation, Sequencing and synthesis of gene:** Different methods of gene isolation, Techniques of DNA sequencing, Artificial DNA synthesis.

9. **Polymerase Chain reaction (PCR):** Basic principles, modifications, applications.

10. **Modifying Genes:** Site-directed mutagenesis, Insertion & Deletion Mutagenesis.

Text / Reference Books:

1. From Genes to Clones by Winnacker. PANIMA
2. Molecular Biotechnology by Pasternack and Glick.
3. From Genes to Genomes: Concepts & Applications of DNA Technology by J.W. Dale & M.V. Schartz.
4. Gene Cloning & DNA Analysis: An Introduction (4^{th} edition) by T.A. Brown.
5. Molecular Cloning by Sambrook, et al.
6. Principles of Gene Cloning by Old and Primrose.

BT- 206 DEVELOPMENT BIOLOGY

1. **History & Basic Concepts:** The origins of developmental biology, Concepts in development – Developmental signals in cell division & differentiation, Role of gene expression in development, Identifying developmental genes, Cell commitment & differentiation, Determination & induction of cell fate, Concept of morphogen & positional information.

2. **An Introduction to Model Systems:** Model vertebrate organisms: X. laevis, Chicken, Mouse, Zebrafish, Model invertebrate organisms: D. melanogaster, C. elegans, Model plant: A. thaliana

3. **Germ Cells & Sex,** Genotypic & phenotypic sex-determiantion in mammals, D. melanogaster and C. elegans, Structure & Formation of germ cells, Fertilization

4. **Patterning the Vertebrate Body Plan :** Axes & Germ Layers, Setting up the body axes, The origin & specification of the germ layers, The Mesoderm & Early Nervous System, Somite formation & Patterning, Role of the organizer region & neural induction

5. **Development of the Drosophila**: Body Plan, Specification of body axes & role of maternal genes, Polarization of body axes during oogenesis, Patterning of early embryo & role of zygotic genes, Segmentation & role of pair-rule genes, Compartments & role of segment polarity genes, Selector & Homeotic genes

6. **Development of Nematodes & Cellular Slime Molds:** Developmental axes determination in C. elegans, Cell-fate specification in C. elegans, Larval development in C. elegans, Vulva development in C. elegans, Patterning of the slug in slime mold, Cell differentiation in slime mold, Aggregation

7. **Morphogenesis:** Kinds of cleavage & blastulation, Types of tissue movement in gastrulation, Gastrulation in amphibians & mammals, Neural tube formation & neural crest migration

8. **Cell Differentiation & Organogenesis:** Models of cell differentiation, Insect imaginal disc & wing development

9. **Molting & Metamorphosis:** Amphibian metamorphosis, Insect metamorphosis

10. **Plant Development:** Pattern development in early embryogenesis of angiosperms, Floral development

Text /Reference Book:

1. Developmental Biology, by Scott F. Gilbert (1997), Sinauer Associates, Inc.

BT-302 BIOINFORMATICS

1. **The Internet and Biologist:** Internet basics, FTP, Gopher, World Wide Web.

2. **The Gen Bank Sequence Database:** Introduction, Primary & Secondary databse, Format vs content: computer vs humans, GenBank Flat File dissection, GCG, ACDEB.

3. **Structure Databases**: Introduction to structures, PDB, MMDB, Structure file formats, Visualizing structural information, Database structure viewers.

4. **Information Retrieval from Biological Databases:** Retrieving database entries, Integrated information retrieval: The entrez system, sequence databases beyond NCBI, Medical Databases

5. **The NCBI Database**: Introduction, SeqIDS, Bioseq: Sequences, Bioseqsets: Collections of sequences, Seq. Annot: Annotating the sequence, Seqdiscr: Describing the sequence

6. **Sequence Alignment and Database Searching**: Introduction, Evolutionary basis of sequence alignment, Optimal alignment methods, Substitution scores & gap penalties, Statistical significance of alignments, Database similarity searching, FASTA, BLAST, Low complexity regions, Repetitive elements

7. **Multiple Sequence Alignment**: Progressive alignment methods, Motifs and patterns, Hocks, MOST, Probe, Presentation methods, Abscript

8. **Phylogenetic Analysis:** Elements of phylogenetic models, data analysis: Alignment, substitution model building, tree building and tree evaluation, building methods, searching for trees, hooting trees, Evaluating trees and data, phylogenetic software Some simple practical consideration

9. **Predictive Methods Using Nucleotide Sequence:** Framework, marking repetitive DNA, Database search, Codon bias detection, Detecting function sites in the DM, Integrated gene passing, Finding tRMA genes

10. **Predictive methods Using Protein Sequences:** Protein identity based on composition, Propsearch, Physical properties based on sequences, secondary structure and folding classes, Sspread sopma, Specialized structures of features, Tertiary structure

11. **Genome Mapping:** Different types of maps: physical, genetical, etc. Synteny, Human genome project, Application of genome mapping, Chromosome maps.

12. **Submitting DNA Sequences to the Databases**: Introduction, Where to submit, What to submit, How to submit on the worldwide web, How to submit with sequin.

Text/ References books:

1. Bioinformatics: A practical guide to the analysis of genes and proteins A.D. Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons.
2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, 2001, Cold Spring Harbor Laboratory Press.

BT-304 FOOD BIOTECHNOLOGY

1. **Historical Background**: History of Microorganisms in food, Historical Developments.

2. **Taxonomy**, role and significance of microorganisms in foods. Intrinsic and Extrinsic Parameters of Foods that affect microbial growth.

3. **Microorganisms** in fresh meats and poultry, processed meats, seafood's, fermented and fermented dairy products and miscellaneous food products.

4. **Starter cultures**, cheeses, beer, wine and distilled spirits, SCP, medical foods, probiotics and health benefits of fermented milk and foods products.

5. **Brewing**, malting, mashing, hops, primary & secondary fermentation: Biotechnological improvements: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl. Beer, wine and distilled spirits.

6. **Nutritional boosts and flavor enhancers:** Emerging processing and preservation technologies for milk and dairy products.

7. **Microbiological Examination** of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods

8. **Food Preservation**, Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food Preservation. Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents.

9. **Storage** Stability Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying, Indicator and Food-borne Pathogens, Other Proven and Suspected Food-borne Pathogens.

10. **Psychrotrophs**: Thermophiles and Radiation-resistant Microorganisms, Characteristics and Growth of Thermophilic Microorganisms, Nature of Radiation Resistance in Microorganisms. Rheology of Food Production.

11. **Consumer perspective and future of food Biotechnology.**

Text / Reference Books:

1. Modern Food Micro-Biology by James M. Jay, (2000), 6th edition, An Aspen Publication, Maryland, USA.
2. Food Microbiology: Fundamentals and frontiers by M.P. Doyle, L.R. Beuchat and Thoma J. Montville, (2001), 2nd edition, ASM press, USA.
3. Food Science and Food Biotechnology by G.F.G. Lopez & G.V.B. Canovas (2003), CRC Press, Florida, USA.

BT-306 PLANT BIOTECHNOLOGY

1. **Introduction:** Definition, Classical vs modern approach

2. **Production of disease free plants:** Explants, shoot tip culture, shoot tip grafting, viricidtel compounds

3. **Micropropagation:** Basic technique, Automation in the area scope as an commercial venture.

4. **Tissue Culture as some of Genetic Variability:** Somaclonal and gametoclonal variation, Selection, Sources and causes of variation, Application in crop improvement.

5. **Protoplast Related Techniques:** Protoplast, Isolation, Culture and fusion, Selection of hybrid cells, regenration of hybrid plants, somatic hybridization and cybridization, Applications in crop improvement.

6. **Plant as Biofactories:** Concept, Production of Chemicals, Pigments, Perfume, Flavors, Insecticides, anticancer agents and other important compounds.

7. **Transformation Techniques:** Physical methods, Agrobacterium, Mediated transformation

8. **Transgenics:** Basic concept and essential steps of the process, Some examples of transgenic plants, Use of suitable promoters, Gene silencing and measures to overcome it, Commercial aspects of the technology.

9. **Nitrogen Fixation:** Basic concepts, nif genes and their regulation, potential scope in crop improvement

10. **Transformation of organelles:** Methods and success, advantages of organller transformation.

11. **Molecular Markers:** Concept, SNPs, RAPD, RFLP, ISSR, STMS, role in crop improvement and genome mapping.

Text / Reference Books:

1. Plant Tissue Culture: Applications and Limitations. S.S. Bhojwani (1990), Elsevier, Amsterdam.
2. Micropropagation: P.C. Debergh and R.H. Zimmerman (1990), Kluwer Academic Publ. Dordrecht.
3. Transgenic plants – Lindsey and Jones
4. Plants, genes & crop improvement, Crispeels – ASPB, 2002
5. Agricultural Biotechnology – A. Altman.

BT-308 DOWN STREAM PROCESSING

1. **Biomolecules of Commercial importance:** Ethanol, citric acid, lysine, steroids, penicillin, dextran, trehalose, subtilisin, chymosin, vitamin B12, hepatitis B vaccine, insulin, erythropoietin, monoclonal antibodies.

2. **Techniques and Instrumentation:** Filtration, centrifugation, aqueous two phase system, ion exchange chromatography, gel permeation chromatography, affinity chromatography, spectrometry, automation, bioassay, automated sequencers, mass spectrometry, ORD, CD

3. **Proteins from microbes, plants and animal sources by classical and modern biotechnology:** Recombinant versus non-recombinant proteins, Microorganisms as source of proteins, Protein production in genetically engineered microorganism such as E. coli, yeast and fungi, Proteins from plants, Production of heterologous proteins in plants, Animal tissues as protein source, production in transgenic animals, animal cell culture, insect cell culture.

4. **Large scale protein purification** Production of factor VIII, t-PA, hepatitis B, Asparaginase, insulin, interferon alfa, glucose oxidase, horse radish peroxidase, Alfa amylase, subtilising, lipase, casein, whey protein concentrate.

5. **A General Study of Various Classes of Commercial Proteins:** Blood products, vaccines, therapeutic antibodies and enzyme hormones and growth factors, interferon, interleukins, industrial enzymes, non-catalytic industrial proteins.

6. **A General Study of Commercial Products other than Proteins:** Bulk organics (ethanol), Biomass (Bakers Yeast), Organic acids (Citric Acid), Amino Acids (L-Lysine), Microbial Transformations (Steroids), Antibiotics (Penicillin), Extra Cellular Polysaccharides (Xanthan Gum), Nucleotides (5-GMP), Vitamins (B_{12}), Pigments (Shikonin)

Text/ References books:

1. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)
2. Process Biotechnology Fundamentals by S.N. Mukhopadhyay (2001). Viva Books Private Limited.

BT-310 BIOSENSORS

1. **Introduction to Biosensors:** Concepts and applications.
2. Biosensors for personal diabetes management.
3. Microfabricated Sensors and the Commercial Development of the I- stat Point-of-Care system.
4. Noninvasive Biosensors in Clinical Analysis.
5. Surface Plasmon Resonance.
6. Biosensors based on Evanescent Waves.
7. Applications of Biosensor-based instruments to the bioprocess industry.
8. Application of Biosensors to environmental samples.
9. Introduction to Biochips and their application in modern sciences.

Text / Reference Books:

1. Commercial Biosensor: Grahm Ramsay, John Wiley & Son, INC. (1998)

BT-312 Biochemical Engineering & Biotechnology

1. **Introduction to Biotechnology:** What is biotechnology, An interdisciplinary pursuit, A three-component central core, Product safety, Public perception of biotechnology, Biotechnology and the developing world.
2. **Amino Acids, Peptides and Proteins:** Structure, Function, Methods of Characterization, Separation Techniques based on their structure and properties.
3. **Nucleic Acids:** Nucleic Acids and Polynucleotides, Classification, Structure, Function, Separation and Characterization Techniques.
4. **Biochemical Energetics:** Energy Yielding and Energy Requiring Reactions, Calculations of Equilibrium Concentrations, Oxidation-Reduction Reactions, Metabolism and ATP Yield. Photosynthetic Phosphorylation, Active Transport, Second Law of Thermodynamics, Enthalpy and Entropy, Activation Energy.
5. **Metabolic Strategies:** General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis.
6. **Bioprocess/fermentation technology:** Bioreactor, Scale-up, Media design, Technology for microbial, mammalian and plant cell culture, downstream processing.
7. **Enzyme Technology:** Nature, Application, Genetic engineering & protein engineering, Immobilised enzymes and Technology of enzyme production.
8. **Biopharmaceuticals:** Introduction to genetic engineering, Antibiotics, Therapeutic proteins, Vaccines & monoclonal antibodies, Gene therapy.
9. **Food and beverage technology:** Introduction, Fermentation, Food processing, Sweeteners, Food wastes, Rapid diagnostics, Public acceptance & safety.
10. **Agricultural and forestry Biotechnology:** Introduction, Plant biotechnology, Forestry, Biological control, Animal biotechnology, Diagnostics in agriculture, Bioremediation.
11. IPR, Safety, Social, moral and ethical aspects of Biotechnology

Text / Reference Books:

1. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
2. Biochemistry by Lehninger. McMillan publishers
3. Biochemistry by Zubey. Wm. C. Brown publishers
4. Biotechnology, John E. Smith
5. Bioprocess Engineering Principles, Pauline M. Doran

BT-401 STEM CELLS IN HEALTH CARE

1. **Introduction**: Stem Cell Biology, Fate Mapping of Stem Cells
2. **Stem Cell Pattern:** Differentiated Parental DNA Chain Causes Stem Cell Pattern of Cell-type Switching in Schizosaccharomyces pombe
3. **On Equivalence Groups** and the Notch/LIN-12 Communication System,
4. **Cell Cycle Control,** Checkpoints, and Stem Cell Biology, Senescence of Dividing Somatic Cells
5. **The Drosophila Ovary**: An In Vivo Stem Cell System
6. **Male Germ-line Stem Cells**
7. **Primordial Germ Cells** as Stem Cells, Embryonic Stem Cells, Embryonal Carcinoma Cells as Embryonic Stem Cells, Trophoblast Stem Cells
8. **Hematopoietic Stem Cells**: Repopulating Patterns of Primitive Hematopoietic Stem Cells, Molecular Diversification and Developmental Interrelationships, Hematopoietic Stem Cells: Lymphopoiesis and the Problem of Commitment Versus Plasticity, Hemangioblast
9. **Mesenchymal Stem Cells** of Human Adult Bone Marrow
10. **Stem Cells and Neurogenesis**
11. **Epidermal Stem Cells:** Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon

Text / Reference Books:

1. Developmental Biology, 6th Edition, Scott F. Gilbert
2. Hematology, William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman
3. Molecular Biology of the Cell, 3rd Edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson
4. Stem Cell Biology by Marshak, 2001, Cold Spring Harbar Symposium Pulblication.

BT-403 ENVIRONMENTAL BIOTECHNOLOGY

1. **Introduction to Environment**: Concept of ecology and ecosystem, environmental pollution (Water, soil and air) noise and thermal pollution, their sources and effects.

2. **Sewage and waste water treatments:** Anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic, and fermentative bacteria-technical process and conditions, emerging biotechnological processes in waste - water treatment.

3. **Solid waste management:** landfills, composting, earthworm treatment, recycling and processing of organic residues.

4. **Biodegradation of xenobiotic compounds**, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

5. **Bioremediation and Biorestoration:** Reforestation through micropropagation, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

6. **Microbial leaching and mining:** Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal.

7. **Environmental Biotechnology in Agriculture:** Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides

8. **Biofuel**: Plant derived fuels, Energy crops, Biogas, Bioethanol, biohydrogen

9. **Environmental genetics**: degradative plasmids, release of genetically engineered microbes in environment.

10. **Biosafety and Biethics in Biotechnology**

11. **Environmental laws and policies**

Text / Reference Books:

1. Environmental Biotechnology by Alan Scragg (1999); Longman.
2. An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Academic Press.

BT-405 PROTEIN BIOTECHNOLOGY

1. **Protein Structure:** Introduction, Overview of protein structure, Higher-level structure, Protein post-translational modification, Protein stability and folding.

1. **Protein Sources:** Introduction, Microorganisms as sources of proteins, Proteins from plants, Animal tissue as a protein source, direct chemical synthesis, Conclusion.

2. **Protein Purification and Characterization:** Introduction, Initial recovery of proteins, Removal of whole cells and cell debrisConcentration and primary purification, Column chromatography, Protein inactivation and stabilization, Protein characterization.

3. **Large-Scale Protein Purification:** Some general principles, Therapeutic protein production: some special issues, Range and medical significance of impurities potentially present in protein-based therapeutic products, Labelling and packing of finished products.

4. **Therapeutic Proteins:** Introduction, Blood products, Haemophilia A and B, Anticoagulants, Thrombolytic agents, Additional blood-related products, Vaccine technology, Vaccines for AIDS.

5. **Therapeutic Antibodies and Enzymes:** Introduction, Antibodies for in vivo application, Therapeutic enzymes.

6. **Hormones and Growth Factors used Therapeutically:** Introduction, Insulin, Glucagon, Gonadotrophins, Growth hormone, Erythropoietin, Other growth factors, Thyrotrophin, Corticotrophin, Prolactin, Peptide Regulatory Factors.

7. **Interferons, Interleukins and Additional Regulatory Factors:** Regulatory factors; cytokines versus hormones, Interferons, Interleukins, Tumour necrosis factors, Colony-stimulating factors, Cytokine toxicity.

8. **Proteins Used for Analytical Purposes:** Introduction, Enzymes as diagnostic/analytical reagents, Biosensors, Antibodies as analytical reagents.

9. **Non-catalytic Industrial Proteins:** Introduction, Functional properties of proteins, Milk and milk proteins, Animal and microbial proteins, Sweet and taste modifying proteins.

Text / Reference Books:

1. Proteins: Biochemistry and Biotechnology by Gary Walsh. (2002): John Wiley & Sons Ltd.
2. Fundamentals of Protein Biotechnology: Edited by Stanley Stein (1990): Marcel Dekker, Inc.

BT-407 Commercialization, Marketing and Management of Biotechnological Products

1. Why there is a need to commercialize biotechnology. Discovery, market needs development process, success rates and costs etc.

2. Creating and marketing the image of the biotechnology Company. Art of negotiation & effective communication.

3. Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up.

4. How to portray management and role of a biotechnology manager, technology decision-making, and resource decision-making etc., Product marketing decision.

5. Role of Research & development University-industry technology transfer arrangements, how and why a biotech company can benefit.

6. Positioning, power and importance of positioning of a company name and product, Workable marketing and the strength of distribution.

7. Effective advertising and marketing. Opportunities international, marketing and lessons to be learned.

8. Indian and foreign prospective of biotechnology, and current challenges for the biotechnology based products.

Text / Reference Book:

1. Positioning by All Rise and Jack Trout (1986), Warner Books.
2. Biotechnology: The science & the business by V. Moser & R.E. Cape (1999) Harwood.
3. Latest review articles and papers on the subject.

HS-409 WRITING SKILLS FOR TECHNICAL PURPOSES

1. **Making Technical Text Readable:** Logic and Organizational Patterns; Language and Visual display.

2. **Gathering Date:** Interviewing; Using the Library/Internet; Listing Reference Material.

3. **Paper and Report Writing:** Organizing a Paper; Writing the Discussion or Body of an Article; Writing the exit; Writing the Lead.

4. **Writing Specific Documents:** Letters and Memos; Job Applications, Cover letters and Resume.

5. **Designing and Writing for Electronic Media:** Using Internet as a Writing Tool; Designing and Writing for Multi-media; Writing and Designing for World Wide Web.

6. Oral Presentations: Listening ans Speaking Skills.

Text / Reference Books:

1. How to Write & Present Technical Information, 3rd Edition, Charles H. Sides, Cambridge University Press. 1999.
2. Garffey, Mary Ellen Business Communication, Cincinnati: South-Western College Publishing, 2000
3. Parley E Stevens and Daniel G Riardaw. Technical Report Writing Today N Delhi AITBS, 1998.

BT-402 INDUSTRIAL BIOTECHNOLOGY

1. **Introduction, Objectives and Scope;** Characteristic and comparison of bioprocessing with chemical processing.

2. Substrates for bioconversion processes and design of media

3. Isolation, preservation and improvement of industrial microorganisms, Cell culture techniques and aseptic transfers

4. Metabolic basis for product formation. Production of secondary metabolites-penicillin, tetracycline etc

5. Process technology for the production of cell biomass and some primary metabolites, e.g. ethanol, acetone-butanol, citric acid, dextran and amino acids.

6. Microbial production of industrial enzymes-glucose isomerase, cellulase & lipases.

7. Applications of bioconversion, transformation of steroids and sterols. Transformation of non-steroidal compounds, antibiotics and pesticides.

7. Bioenergy-fuel from biomass, production and economics of biofuels.

8. Metal recovery and microbial desulfurization of coal.

Text / Reference Books:

1. Comprehensive Biotechnology Vol. 1- 4: M.Y. Young (Eds.), Pergamon Press.
2. Biotechnology: A Text Book of Industrial Microbiology: T.D. Brock, Smaeur Associates, 1990.
3. Industrial Microbiology: L.E. Casida, Willey Eastern Ltd., 1989.
4. Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987.
5. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RIT, Stockholm.
6. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Rutledge & A Sasson, Cambridge Univ. Press, Cambridge.
7. Biotechnology - a handbook of industrial microbiology: W. Crueger and A. Crueger.
8. Microbial Biotechnology: Channarayaappa, University press, Hyderabad, 2003

BT-404 INTELLECTUAL PROPERTY RIGHTS IN BOTECHNOLOGY

1. **WTO:** As an international agency controlling trade among nations. WTO with reference to biotechnological affairs, TRIPs.

2. **General Introduction:** Patent claims, the legal decision – making process, ownership of tangible and intellectual property.

3. **Basic Requirements of Patentability:** Patentable subject matter, novelty and the public domain, non obviousness

4. **Special issues in Biotechnology Patents:** Disclosure requirements, Collaborative research, Competitive research, plant

5. **Plant biotechnology:** Indian patents and foreign patents, Plant variety protection act, the strategy of protecting plants.

6. **Patent Litigation:** Substatritive aspects of patent litigation, Procedural aspects of patent litigation, different Doctrines

7. Recent Developments in Patent System and Patentability of biotechnological inventions.

8. **IPR issues in Indian Context:** Role of patent in pharmaceutical industry, computer related innovations

9. **Case studies:** Rice, Haldi, neem, etc. and challenges ahead

Text / Reference Books:

1. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
2. Intellectual property rights – Ganguli – Tata McGraw-Hill
3. Intellectual property right – Wattal – Oxford Publishing House.

BT-406 DIAGNOSTICS TECHNIQUES

1. **General Clinical Laboratory Techniques & Procedure:** Chemical & Related substrates, volumetric analysis, Balancing & Weighing, Concept of solute & solvent, Units of measurement

2. **Specimen Collection & Processing:** Specimen collection (Blood, urine, spinal fluid, saliva synovial fluid, Amniotic fluid), Preservation, transportation

3. **Selection & Interpretation of Lab. Procedure:** Classification of BIAS, Sensitivity and specificity, Receiver Operator Characteristics, Interpretation a test

4. **Quality Management:** Fundamentals of total quality management, Element of QAP, External quality assessment and proficiency testing programme.

5. **Clinical Enzymology:** Principle of diagnostic enzymology, Liver, cardiac and skeletal enzyme, Digestive enzyme, Miscellaneous enzyme

6. **General Function Tests:** Liver function test, Cardiac Function Test, Renal Function Test, Thyroid Function test, Reproductive endocrime function test

7. **Immunodiagnostics:** Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections.

8. **Product Development:** Immunoassay Classification and Commercial Technologies, Assay Development, Evaluation, and Validation, Reagent Formulations and Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.

9. **DNA based diagnostics:** PCR, RFLP, SSCP, Microarrays, FISH, In-situ hybridization, Case studies related to bacterial, viral and parasitic infections.

10. **Cell based diagnostics:** Antibody markers, CD Markers, FACS, HLA typing, Bioassays.

11. **Biosensors**: Concepts and applications, Biosensors for personal diabetes management, Noninvasive Biosensors in Clinical Analysis, Introduction to Biochips and their application in modern Sciences, Introduction to Nanotechnology.

Text / Reference Books:

1. Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R. Ashwood, Harcourt Brace & Company Aisa Pvt. Ltd.
2. Commercial Biosensors: Graham Ramsay, John Wiley & Son, INC. (1998).
3. Essentials of Diagnostic Microbiology, Lisa Anne Shimeld.
4. Diagnostic Microbiology, Balley & Scott's.
5. Tietz Text book of Clinical Biochemistry, Burtis & Ashwood.
6. The Science of Laboratory Diagnosis, Crocker Burnett.

BT-408 BIOSAFETY & BIOETHICS

1. **Biotechnology and Society**: Introduction to science, technology and society, biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalisation and development divide.

2. **Bioethics**: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc.

3. **Biotechnology and Bioethics**: The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

4. **Biosafety concepts and issues**: Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world.

5. **Biosafety in the laboratory institution**: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution

6. **Biosafety regulations** in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad

7. **Biotechnology and food safety**: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance.

8. **Ecological safety assessment** of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton).

9. **Biosafety assessment of biotech pharmaceutical products** such as drugs/vaccines etc.

10. **International dimensions in biosafety**: Catagena protocol on biosafety, bioterrorism and convention on biological weapons

Text / Reference Books:

1. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
2. Fleming, D.A., Hunt, D.L., (2000). Biological safety Principles and practices (3rd Ed). ASM Press, Washington.
3. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH.
4. Encyclopedia of Bioethics