AUGUST 2008

SCHEME OF EXAMINATION

&

SYLLABUS FOR B.Tech-M.Tech (Dual Degree)

(Semester 1 to 8)

in

Biotechnology

YEAR 2008 ONWARDS

UNIVERSITY SCHOOL OF BIOTECHNOLOGY

GGS INDRAPRASTHA UNIVERSITY

KASHMERE GATE

DELHI - 110 006

Present Address: Sec-16C, Dwarka, New Delhi-110075

SCHEME OF EXAMINATION FOR BACHELOR OF BIOTECHNOLOGY

L	T	P	Credits	Hours
15	5	12	26	32

FIRST SEMESTER EXAMINATION

Code No.		L	T/P	Credits
THEORY PAPERS				
BA-135	Foundation course in Physico-Inorganic Chemistry – I	2	1	3
BA-137	Foundation course in Physics-I	2	1	3
EMBT-133	Life Sciences – I	3	1	4
BA-131	Essential of Mathematics – I	3	1	4
BT-115	Concepts in Biotechnology	2	1	3
IT- 105	Introduction to Computers	3	0	3
Practicals* **:**				
BA-183	Chemistry - I Lab	0	2	1
BA-185	Physics - I Lab	0	2	1
EMBT-181	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

L	T	P	Credits	Hours
16	6	10	27	32

Code No.		L	T/P	Credits
THEORY PAPERS				
BA-138	Foundation Course in Physics-II	2	1	3
BA-132	Essential of Mathematics-II	3	1	4
BA-136	Foundation Course in Organic Chemistry-II	2	1	3
EMBT-134	Life Sciences-II	3	1	4
BT-124	Laboratory Techniques in Biotechnology	3	1	4
IT -120	Electrical Science	3	1	4
Practicals *:				
BA-186	Physics - II Lab	0	2	1
BA-184	Chemistry – II Lab	0	2	1
EMBT-182	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**

***Practicals will be based on theory courses.**

THIRD SEMESTER EXAMINATION

L	T	P	Credits	Hours
15	6	14	29	35

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	4	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**	**6/14**	**29**

FOURTH SEMESTER EXAMINATION

L	T	P	Credits	Hours
14	5	14	26	33

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	4	2
BT-258	Immunology –Lab	0	2	1
TOTAL		**14**	**5/14**	**26**

***Practicals will be based on theory courses.**

FIFTH SEMESTER EXAMINATION

L	T	P	Credits	Hours
12	5	15	27	32

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

L	T	P	Credits	Hours
14	6	12	28	32

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*:		0	3	2
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			
TOTAL		**12**	**5/12**	**25**

***Practicals will be based on theory courses.**

****Credits not be cosidered for B. Tech. (Biotechnology students)

SEVENTH SEMESTER EXAMINATION

L	T	P	Credits	Hours
13	5	12	25	30

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

L	T	P	Credits	Hours
9	3	18	30	30

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	Molecular and Cellular Diagnostics	2	1	3
BT-408	Biosafety & Bioethics	2	0	2
Project work/Viva-voce *:				
BT-450	Project Work	0	18	18
TOTAL		**9**	**3/18**	**30**

***Practicals will be based on theory courses.**

Note:
Total no. of credits = 215 credits
Credits to be earned by students to qualify B. Tech (Biotechnology) degree = 200 Credits.

FIRST SEMESTER EXAMINATION

L	T	Credits	Hours
2	1	3	26

BA-135 FOUNDATION COURSE IN PHYSICO-INORGANIC CHEMISTRY - I

Chemical Bonding:

1.Ionic Bond- energy changes, lattice energy Born Haber Cycle, Covalent bond-energy changes, Potential energy curve for H2 Molecule, characteristics of covalent compound. **(4)**

2.Co-ordinate bond - Werner's Theory, effective atomic numbers, isomerism in coordinate compounds. Hydrogen bonding. **(2)**

3.Concept of hybridization and resonance, Valance Shell Electron Repulsion theory (VSEPR). Discussion of structures of H2O, NH3, SiF4. Molecular orbital theory, Linear combination of atomic orbitals (LCAO) method. Structure of simple homo nuclear diatomic molecule like H2, N2, O2, F2. **(4)**

Acids and Bases:

4.Basics of acidities and basicities, electrolytic dissociation, concept of strengths of acids and bases, ionization of water, concept of pH and its scale, Buffer solutions, Buffer solution of weak acid and its salt, calculation of pH of buffer solution, Henderson equation, acid-base indicators and theory of indicators. **(4)**

Catalysis:

5. Criteria for Catalysis-Homogeneous Catalysis, acid-base, Enzymatic catalysis, Catalysis by metal salts. **(2)**

6. Heterogeneous catalysis - concepts of promoters, inhibitors and poisoning, Physiosorption, Chemisorption, Surface area, industrially important process. **(2)**

Polymers:

7. 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. **(2)**

8. 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. **(2)**

Colloids:

9. Colloidal state, classification of colloidal solution, true solution, colloidal solution and suspensions, preparation of sol, Purification of colloidal solutions. **(2)**

10. General and optical properties, 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. **(2)**

Text / Reference Books:

1. Concise Inorganic Chemistry, 5th Edition by J.D. Lee, *Blackwell Publishing* (1999).
2. Advance Chemistry by Philip Mathews, *Cambridge University* Press (1996).
3. Basic Inorganic Chemistry, 3rd Edition by F. A. Cotton, G. Wilkinson & P. L. Gaus, *Wiley*(1995).
4. Physical Chemistry, 6th Edition by P. W. Atkins, *W.H. Freeman & Company*; (November 1997).

FIRST SEMESTER EXAMINATION

L	T	Credits	Hours
2	1	3	30

BA-137 FOUNDATION COURSE IN PHYSICS - I

1. **Interference By Division Of Wave front:** Coherence and coherent sources, Interference by division of wave front. Young's double slit experiment, Fresnels' biprism **(3)**

2. **Interference By Division Of Amplitude:** Interference by division of amplitude. Thin films, Newton's rings, Michelson's Interferrometer, Fabry Perot Interferometer **(3)**

3. **Diffraction:** Fresnel and Fraunhoffer types of diffraction. Fraunhofer diffraction: Single slit, double slit, circular aperture. Fresnel Diffraction, narrow slit. **(3)**

4. **Diffraction–Applications:** Fraunhofer diffraction: N-slit. Diffraction grating - wavelength determination, resolving power and dispersive power. Resolving power of optical instruments – Rayleigh criterion. Fresnel Diffraction: zone plate. **(3)**

5. **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. **(3)**

6. **Introduction To Lasers:** Introduction, Coherence, Einstein A and B coefficients, population inversion, Basic principle and operation of a laser, **(3)**

7. **Lasers Types And Applications:** Types of lasers, He-Ne laser, Ruby laser, semi-conductor laser and holography. **(3)**

8. **Fibre Optics:** 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). **(3)**

9. **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). **(3)**

10. **Introduction to Quantum Mechanics:** Basic postulates of quantum mechanics-the wave function - its physical interpretation, The Schrodinger equation. **(3)**

Text / Reference Books:

1. Modern Physics by A. Beiser, *Tata Mc Graw Hill Publishing Co*.
2. Optics by A.K. Ghatak, *Tata Mc Graw Hill Publishing Co.*
3. Introduction to Physical Optics by Jenkin & White, *Mc Graw Hill Publishing Co*

FIRST SEMESTER EXAMINATION

L	T	Credits	Hours
3	1	4	40

EMBT-133 LIFE SCIENCES - I

1. **Origin of Life:** History of earth, theories of origin of life nature of the earliest organism. **(2)**

2. **Varieties of Life:** Classification, Five kingdoms, viruses (TMV, HIV, Bacteriophage), Prokaryote (Bacteria-cell structure, nutrition, reproduction), Protista, Fungi, Plantae and Animalia. **(5)**

3. **Chemicals of Life:** (Biomolecules)- Carbohydrates lipids, amino acids, proteins, nucleic acids, and identification of biomolecules in tissues. **(6)**

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)**

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. **(5)**

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. **(6)**

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. **(5)**

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 mechanism 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. **(6)**

Text / Reference Books:

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

FIRST SEMESTER EXAMINATION

L	T	Credits	Hours
3	1	4	40

BA-131 ESSENTIAL OF MATHEMATICS –I

1. Algebra of matrices, Row and Column operations, Inverse of matrix, Systems of linear equations- consistency and inconsistency, Cramer's rule, Rank of a matrix. **(4)**

2. Quadratic forms, Eigenvalues and eigenvectors of a matrix, Diagonalization of a matrix, Cayley-Hamilton theorem (without proof) **(5)**

3. Quadratic equations, De-Moivre's theorem and its applications **(4)**

4. Limits, Continuity and Differentiation **(5)**

5. Successive differentiation, Leibnitz's Theorem, Indeterminate forms **(4)**

6. Mean Value Theorems: Rolle's, Lagrange's, Taylor's and Maclaurin theorems and expansions and their applications **(6)**

7. Sequences and its convergence, Convergence and divergence of a series, Comparison test, Ratio test, Cauchy's n^{th} root test, Leibnitz's test (all tests without proof), Absolute and Conditional convergence**.** **(6)**

8. Partial derivatives, Chain rule, Differentiation of implicit functions, exact differentials. Maxima, Minima and Saddle points, Method of Lagrange multipliers. **(6)**

Text / Reference Books:

1. Advanced Calculus by D.V.Widder, *Prentice Hall, NY*
2. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney, 6^{th} edition, *Addision Wesley/Narosa*, 1985.
3. Engineering Mathematics by K.A.Stroud, *Palgrave.*
4. Advanced Engineering Mathematics by K.A.Stroud, *Industrial Press, Inc*., Newyork.
5. Advanced Engineering Mathematics by Alan Jeffrey, *Harcourt, Academic Press*.
6. Advanced Engineering Mathematics by Petter V.O'Neil, *Thomson*.
7. Differential Calculus by Shanti Narayan, *S. Chand & Co*.
8. A text book of Matrices by Shanti Narayan, *S. Chand & Co*.
9. Advanced Engineering Mathematics by E. Kreyszig 5^{th} Edition, *Wiley Eastern*, 1985.

FIRST SEMESTER EXAMINATION

L	T	Credits	Hours
2	1	3	32

BT-115 CONCEPTS IN BIOTECHNOLOGY

1. **Introduction to Biotechnology:** Definitions, Historical perspectives, Scope and importance, Commercial potential and interdisciplinary challenge. **(7)**

2. **Recombinant DNA Technology:** Introduction, Tools of rDNA Technology, Making Recombinant DNA, Introduction of Recombinant DNA into host cells, introduction to screening techniques for Identification of Recombinants, Polymerase Chain Reaction (PCR). Introduction to screening technologies for identification of recombinants. **(3)**

3. **Protein Structure and Engineering:** Introduction to the world of Proteins, 3-D Shape of Proteins, Structure Function relationship in Proteins, Purification of Proteins, introduction to Protein Designing and Proteomics. **(4)**

4. **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. **(3)**

5. **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, Bioethics in Plant Genetic Engineering. **(4)**

6. **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, Bioethics in Animal Genetic Engineering. **(4)**

7. **Biotechnology and Society:** Introduction to Patenting - Criterion for patents, Reading a patent, National and International Patent Laws, Ethical issues in agriculture and health care, Biotechnology in India and global trends; Product safety and Marketing. **(2)**

8. **Introduction to Bioinformatics:** Introduction to databases and their application. Introduction to Functional Genomics. **(2)**

9. **Solutions and buffers:** Modes of expressing concentration of a solution, types of solution, Acids and bases, dissociation of water, concept of pH, Buffer system, criteria for selection of buffers. **(2)**

10. **Introduction to Statistical analysis**: Presentation of experimental data, introduction to data, Analysis of graph paper with Logarithmic Coordinates, General procedure for plotting data. **(1)**

Text / Reference Books:

1. Biotechnology by Smith, *Cambridge Press*.
2. Introduction to Genomics, Arthur M Lest, *Oxford*
3. Gene cloning and DNA Analysis. An introduction. T. A Brown, 4th Edition. *Blackwell Science*.

FIRST SEMESTER EXAMINATION

L	T	Credits	Hours
3	0	3	40

IT–105 INTRODUCTION TO COMPUTERS

1. **Introduction:** Overview of computer organization and historical perspective computer applications in various fields of science and management. **(5)**

2. **Data representation:** Number systems, character representation codes, Binary, hex, octal codes and their inter conversions. Binary arithmetic, floating point arithmetic, signed and unsigned numbers. **(5)**

3. **Data storage:** Primary and Secondary storage. Introduction to various computer devices such as keyboard, mouse, printers, disk files, floppies etc. **(5)**

4. 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. **(5)**

5. **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. **(5)**

6. **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, and 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. **(15)**

Text / Reference Books:

1. Fundamentals of Computers by V. Raja Raman, *Prentice Hall of India.*
2. 'C' Language by Brian Gottfried, *Schaum Series*.
3. Introduction to Computers by Leon & Leon. *Academic Press*

SECOND SEMESTER EXAMINATION

L	T	Credits	Hours
2	1	3	28

BA-138 FOUNDATION COURSE IN PHYSICS – II

1. **Electricity and Magnetism- Basics:** 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 **(3)**
2. **Electricity and Magnetism-applications:** Magnetic and electrostatic focusing, Hall effect, determination of e/m by cathode ray tube, positive rays, Electron microscope, Cyclotron and Betatron. **(4)**
3. **Classical and Quantum Statistics:** The Statistical distributions: Maxwell Boltzmann, the Black-body spectrum and failure of classical statistics to give the correct explanation, Bose-Einstein and Fermi-Dirac statistics, their comparisons, Fermions and Bosons. **(3)**
4. **Applications of Classical and Quantum Statistics:** Applications of Maxwell-Boltzmann statistics - Molecular speed and energies in an ideal gas, the application of Bose-Einstein statistics to the Black-body radiation spectrum, Fermi-Dirac distribution to free electron theory, electron specific heats, Fermi energy and average energy - its significance. (**4)**
5. **Band Theory of Solids:** Origin of energy bands in solids, motion of electrons in a periodic potential- The Kronig-Penny model (qualitative). Brillouin zones, effective mass Metals. Semi-metals. Semi-conductors and insulators and their energy band structure. **(3)**
6. **Semiconductors and their Applications:** 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 reverse biased diodes- its characteristics, tunnel diode, zener diode, photo-diode, LED, the photo-voltaic cell **(4)**
7. **Superconductivity:** Introduction to superconductivity, the Meissner effect, Type I and II superconductors, the Josephson effect, flux quantization, Cooper pair, the BCS theory (qualitative) **(3)**
8. **Applications of Superconductors:** Magnetic levitation, superconducting magnets, Josephson junctions and Squids. **(4)**

Text / Reference Books:

1. Modern Physics by Arthur Beiser, *Tata Mc Graw Hill Publishing Co*.
2. Introduction to Solid State Physics by Charles Kittel, *Wiley.*
3. Electronic Principles by Albert Paul Malvino, *Tata Mc Graw Hill Publishing Co.*

SECOND SEMESTER EXAMINATION

L	T	Credits	Hours
3	1	4	42

BA-132 ESSENTIAL OF MATHEMATICS – II

1. Concavity and Convexity of curves, Asymptotes, Singular points, Curve tracing. **(6)**

2. Integration : Methods of Integration, Integration of algebraic, rational, trigonometric functions and irrational functions, Integration by parts, Substitution method, Definite integrals and its properties. **(6)**

3. Reduction formulae of trigonometric functions, Definition of improper integrals, Beta-Gamma functions and their properties. **(5)**

4. Formation of ordinary differential equation's (ODE), Definition of order and degree, Solutions of ODE's of first order: Method of separation of variables, Homogeneous and non-homogeneous equations, Exactness and integrating factors, Linear equations and Bernoulli's equations. **(5)**

5. Linear ODE's of nth order: Solutions of homogenous and non-homogenous equations, Operator method. Method of undetermined coefficients and variation of parameters. **(6)**

6. Power series method of solution of ODE, Legendre's Equation, Legendre's polynomials, Bessel's equation, Bessel's function of first kind. **(6)**

7. Introduction to probability theory, Definition of sample space, Event, Event space, Conditional probability. **(4)**

8. Additive and Multiplicative laws of probability, Baye's theorem, Application based on these results. **(4)**

Text / Reference Books:

1. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney, 6th edition, *Addison Wesley/Narosa,* 1985.
2. Differential Calculus by Shanti Narayan, *S. Chand & Co*.
3. Advanced Engineering Mathematics by E. Kreyszig, 5th Edition, *Wiley Eastern*, 1985.
4. Engineering Mathematics by K.A.Stroud, *Palgrave.*
5. Advanced Engineering Mathematics by K.A.Stroud, *Industrial Press, Inc*., Newyork.
6. Advanced Engineering Mathematics by Alan Jeffrey, *Harcourt Academic Press*.
7. Advanced Engineering Mathematics by Petter V.O'Neil, *Thomson*.
8. Advanced Calculus", Schaum's Outline Series, *Mc Graw Hill Ed*.
9. Advanced Calculus by D.V.Widder, *Prentice Hall*, NY
10. Differential Equations by S.L.Ross, *John Wiley*.
11. Differential Equations by N.M. Kapoor, *Pitamber Pub. Co*.
12. Probability, Schaum Outline Series, *Mc. Graw Hill*.

SECOND SEMESTER EXAMINATION

L	T	Credits	Hours
2	1	3	28

BA-136 FOUNDATION COURSE IN ORGANIC CHEMISTRY – II

1. **Electronic Displacements:** Inductive, mesomeric, field effect and resonance effect - resonance energy and its significance, (vertical and empirical resonance energy). Hyperconjugation: concept and consequences. (**2)**
2. **Reactive Iintermediates:** Generation, structure and general reactions of carbocations, carbanions, free radicals, carbenes (singlet and triplet) and benzyne. Wagner-Meerwein rearrangement, Electrophiles and nucleophiles, concepts of acids and bases. Arrhenius, Lowry-Bronsted and Lewis theory of acids and bases (HSAB), Carbon acids (active methyiene groups), super acids, Correlation of structure with acidity and basicity. Bonds weaker than covalent bond: Hydrogen bonding - nature, types, stability and effects, vander Waals forces. (**5)**
3. **IUPAC Nomenclature:** Systematic IUPAC nomenclature of different classes of compounds including aromatic, bicyclic, and spiro compounds and polyfunctional compounds. (**2)**
4. **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 and axis of symmetry, Conformations: Conformations around a C-C bond in acyclic compounds, Structure of different cycloalkanes. Strain in acyclic and acyclic compounds. Cyclohexane conformations, Stereochemistry of disubstituted cyclohexanes. Geometrical isomerism- Concept, E and Z nomenclature, Stereoselective and specific Reactions. (**8)**
5. **pΠ - dΠ Bonding** in organic compounds, ylids (S and P), Wittig reaction. (**2)**
6. **Tautomerism:** Cationotropy and anionotropy, Prototropic shifts in different systems, ring-chain tautomerism and valence tautomerism, Claisen rearrangement. (**2)**
7. **Alkanes:** Methods of preparation, Source-petroleum and coal in brief, Cracking and reforming. (**2)**
8. **Alkenes:** Methods of preparation. Reactions: Hydrogenation, hydroboration, 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. (**5)**

Text / Reference Books:

1. Modern Organic Chemistry by D. R. Boyed.
2. Organic Chemistry by I. L. Finar, Addison-Wesley Longman, Limited
3. Organic Chemistry by Roger Macomber. *University Science Books.*
4. Organic Chemistry Reaction Mechanism by Jerry March, *McGrawHill Companies*

SECOND SEMESTER EXAMINATION

L	T	Credits	Hours
3	1	4	40

EMBT–134 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. **(6)**

2. **Homeostasis:** Control system in biology, control of blood glucose level, temperature regulation in endothermic animals, the liver and its importance. **(4)**

3. **Mendalian Analysis:** Experiments of Mendel, Simple mendalian genetics in humans, in agriculture, Variants and genetic dissection. **(4)**

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)**

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. **(7)**

6. **Continuity of Llife:** Chromosome, cell cycle, mitosis and meiosis, techniques to study mitosis and meiosis. **(4)**

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. **(5)**

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.) (**5)**

Text / Reference Books:

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

SECOND SEMESTER EXAMINATION

L	T	Credits	Hours
3	1	4	39

BT–124 LABORATORY TECHNIQUES IN BIOTECHNOLOGY

1. **pH:** Concept of pH, Henderson Hasselbach equation, preparation of Buffers, composition of some commonly used buffers, pH meters. **(3)**

2. **Colorimetry and 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 dichroism & their applications. **(5)**

3. **Cell Separation:** Flow cytometry, magnetic beads, elutriator. **(3)**

4. **Microscopy**: Basic principles, instrumentation, sample preparation for optical, phase contrast, interference, polarization, inverted fluorescence, confocal & electron microscopes & their applications. **(4)**

5. **Microtomy:** Principles & types, sample preparation & sectioning parameters. **(2)**

6. **Centrifugation:** Principle, types of centrifuges, differential and gradient ultracentrifugation-preparative & analytical. **(5)**

7. **Chromatography:** Principles, methodology and applications of chromatography using paper, thin layer, column (gel filtration, ion exchange, affinity), gas, HPCL, FPCL. **(4)**

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). **(5)**

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. **(4)**

10. **Biophysical Techniques:** X-ray crystallography Nuclear Magnetic Resonance (NMR) spectra, magnetic Resonance Imaging (MRI), lasers in biology and medicine, Mass spectrometry. **(4)**

Text / Reference Books:

1. Biochemical Calculations by Irwin H. Segel, 2nd Edition, *John Wiley & Sons*, 1975
2. Introductory practical Biochemistry by S. K. Sawhney & Randhir Singh; *Narosa Publishing house*, 2000.

SECOND SEMESTER EXAMINATION

L	T	Credits	Hours
3	1	4	36

IT–120 ELECTRICAL SCIENCE

1. **Properties of Conductors and Insulators :** Basic laws of Electrical Engineering, Temperature Resistance Coefficients. **(5)**

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. **(6)**

3. **Alternating Currents :** Peak, Average and RMS values for alternating currents, Power and Power factor , Resistance, Inductance and Capacitance, Resonance, Q Factor. **(5)**

4. **Measuring Instruments :** Electromagnetism, Moving Coli and Moving Iron, Instruments, Construction Instruments, Attraction and Repulsion type, Permanent Magnet and Eletrodynamics, Dynamometer type. **(5)**

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. **(5)**

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. **(5)**

7. **Transformers:** Construction, Regulation and efficiency calculations, Open and short circuit tests. **(5)**

Text / Reference Books:

1. Electrical Engineering Fundamentals by Vincent DEL TORO. HUGHES, Electrical Technology. *Englewood Cliffs, N.J., Prentice-Hall* [1972]

THIRD SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-201 MICROBIOLOGY

1. **Microbes in Human Life:** Introduction of microorganisms, Brief history of microbiology, Microbes & human welfare, Microbes & disease. **(2)**

2. **Functional Anatomy of Prokaryotic and Eukaryotic Cells:** Simple, differential and special stains for microscopy, Size, shape and arrangement of bacterial cells, Structure of the cell and cell wall. **(4)**

3. **Microbial Metabolism, Catabolic and Anabolic reactions:** Enzymes, energy production and carbohydrate metabolism, Lipid and protein catabolism, Photosynthesis, Bacterial identification by energy production mechanism, Metabolic diversity and pathways of energy use, Integration of metabolic pathways. **(4)**

4. **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. **(4)**

5. **A Survey of the Microbial World:** Classification of microorganism, Methods of classification and identification of microorganisms. **(2)**

6. **The Prokaryote Groups:** Domain bacteria, Proteobacteria, Nonproteobacteria Gram -ve and Gram +ve bacteria, Bacterial diversity. **(2)**

7. **Eukaryotic Groups**: Fungi**,** Lichens, Algae, Protozoa, and Helminthes. **(2)**

8. **Viruses:** Viral structures, Cultivation, identification and viral multiplication. **(2)**

9. **Principles of Disease and Epidemiology:** Mechanism of microbial pathogenicity, history, spectrum and action of antimicrobial drugs, Tests to guide chemotherapy and effectiveness of chemotherapeutic agents. **(4)**

10. **Applied and 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. **(4)**

Text / Reference Books:

1. Microbiology: An Introduction by Tortora, Funke and Case. 7th Edition, 2001
2. Microbiology by Davis, Dulbecco, Eisen and Ginsburg, Lippincott Williams and Wilkins, 4 subedition , 1990.
3. Introduction to Microbiology by Ross, Addison-Wesley Educational Publishers,Inc. 2nd edition, 1986.
4. General Microbiology: Stainier, Adelberq and IngrahamMacmillan Press ltd, 1987.

THIRD SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

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. **(6)**

2. **Amino Acids, Peptides and Proteins:** Structure, Function, Methods of Characterization, Separation Techniques based on their structure and properties, Clinical Significance, Biosynthesis. **(6)**

3. **Carbohydrates:** Mono and Polysaccharide, Classification, Structure, Function, Separation and Characterization Techniques, Clinical significance, Biosynthesis. **(5)**

4. **Lipids:** Classification, Structure, Function, Separation and Characterization Techniques, Clinical Significance. **(6)**

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

6. **Vitamins and Micro and Macro Nutrients:** classification, Structure, Function, Separation and Characterization Techniques, Clinical Significance. **(5)**

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. **(7)**

Text / Reference Books:

1. Biochemistry by Lubert Stryer, W. H. Freeman & Company, NY, 4rd Edition, 1995.
2. Lehninger Principles of Biochemistry by Lehninger, Nelson and Cox, W. H. Freeman & Company, 4th Edition, 2004
3. Biochemistry by Zubey. Wm. C., Brown publishers 4th edition,1998.

THIRD SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT- 205 CELL BIOLOGY

1. **The Cell:** A macromolecular assembly, cellular compartmentalization, organeller architecture. **(2)**
2. **The Nucleus:** The nuclear envelope, Chromosomal DNA and its packaging, chromosome and heterochromatin, variation in chromosome size and number. **(6)**
3. **Cytoskeleton:** The nature of the cytoskeleton, Intermediate Filaments, Microtubules, Cilia and Centrioles, Actin Filaments, Actin-binding Proteins, Cell motility. **(4)**
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. **(4)**
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, Ion pumps. **(4)**
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. **(6)**
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. (**6)**
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. **(4)**
9. **Cancer:** Cancer as a Microevolutionary Process, Tumor cells, Proto-oncogenes and viral oncogenes, Tumor suppessor genes. **(4)**

Text / Reference Books:

1. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp. John Wiley & Sons1998.
2. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Garland publishing, New York Fifth Edition. 2007.
3. ***The Cell***: A Molecular Approach by Geoffrey M. *Cooper* and Robert E. Hausman, *ASM Press.*, Fourth edition.
4. *Cellular and Molecular Biology. De Robertis & De Robertis Jr. Waverly, Eighth edition 1997.*

THIRD SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-209 GENETICS

1. **Introduction to Genetics:** Genetics and basic concepts, Genes and Environment, Techniques of genetic analysis, Epigenetics. **(2)**

2. **Chromosome Theory of Inheritance:** The chromosome Theory of heredity, Sex chromosomes, Sex linkage, the parallel behavior of autonomic genes and chromosomes. **(2)**

3. **Mendelian Analysis:** Mendel's laws of inheritance, Interaction of genes, Variations dominance, Multiple alleles, lethal alleles, Pleioteorism, Modified mendelian inheritance, Penetrance and expressivity. **(4)**

4. **Linkage:** Basic eukaryotic chromosome mapping, The discovery of linkage, 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. **(6)**

5. **Fine Structure of Gene:** The concept of promoter, Coding sequence, Terminator, Induction of gene expression. **(1)**

6. **Mutations:** Spontaneous mutations, induced mutations, Mutagens, Molecular basis of mutations. **(4)**

7. **Biochemical Genetics:** Inborn errors of metabolism, One gene – one enzyme hypothesis, One gene – one protein, One gene – one polypeptide, colinearity. **(2)**

8. **The Extranuclear Genome:** The concept of extranuclear genome in higher plants and animals, Overview of mitochondrial genome, Chloroplast genome. **(3)**

9. **Population Genetics:** Darwin's evolution, Variation and its modulation, Effect of sexual reproduction on variation, Sources of variation, Selection quantitative genetics. **(2)**

10. **The Dynamic Genome:** Discovery of transposable elements in maize, Transposable Element in prokaryotes and eukaryotes. **(3)**

11. **Genetic Disorders:** Genetics and Society. **(1)**

Text / Reference Books:

1. Introduction to Genetic Analysis by Griffiths, Wessler, Lewontin and Carroll, Freeman and Company, 9th Edition, 2008.
2. Genetics: Classical to Modern by P. K. Gupta, Rastogi Publications, Meerut, 2nd Edition.
3. Concepts of Genetics, Klug & Cummings, Prientice Hall.
4. Genetics: Analysis of Genes and Genomes by Hartl & Jones, Jones and Barlett, 6th Edition.

THIRD SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-211 BIOSTATISTICS

1. **Presentation of Data:** Frequency distribution, Graphical presentation of data by histogram, frequency curve and cumulative frequency curves. **(3)**

2. **Measure of Location and Dispersion:** Mean, Median, Mode and their simple properties (without derivation) and calculation of median by graphs: range, mean deviation, Standard deviation, Coefficient of variation. **(3)**

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)**

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. **(4)**

5. **Sampling:** Concept of population and sample, Random sample, Methods of taking a simple random sample. **(4)**

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. **(6)**

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. **(6)**

Text / Reference Books:

1. Statistical methods in biology by Norman T.J. Bailey, Cambridge University Press 3rd Edition, 1995.
2. Methods in Biostatistics B. K. Mahahan, Jaypee Brothers, Sixth edition, 1997.
3. Biostatistical analysis. Jerold Zar, Pearson Education, 4th Edition.
4. Biostatistics; A foundation for analysis in the Health Sciences, Wiley, 7th Edition.

THIRD SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

CT-211 CHEMICAL ENGINEERING - I

1. Chemical Engineering discipline, structure and practice. **(4)**

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. Material balance for non-reacting and reacting systems, recycle and by pass. **(20)**

3. Heats of solution, mixing and reactions. Types of energy and first law of thermodynamics. Energy balance for non-reacting and reacting systems. Calculation of flame temperature and adiabatic reaction temperature. Properties of fluids & fluid statistics. Mechanical energy balance. **(10)**

4. Flow of incompressible fluids: laminar and turbulent flows, velocity distribution in pipes, pressure drop in pipes and fittings. Stokes law and its applications. Flow in packed beds. Flow measurement: Orifice & Venturi meter. Pumps and their characteristics. **(6)**

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.

FOURTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-202 IMMUNOLOGY

1. **Introduction to Immunology:** Properties of immune response, Innate and acquired immunity, Active and passive immunity. **(2)**

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. (**4)**

3. **Molecular Immunology**: - Molecular structure of antibody, Classification, Isotypes, Synthesis assembly and expression of immunoglobulin molecules, Function and diversity, Generation of anti-body diversity. **(4)**

4. **Antigens:** Nature of antigens, Different characteristics of antigens, Mitogens, Hapten, Immunogen, Adjuvants. **(2)**

5. **MHC**: Discovery of MHC complex, Role of MHC, Structure of MHC molecule, Binding of peptides to MHC molecules, MHC restriction. (**3)**

6. **Effecter Mechanism of Immune Response:** Cytokines, T- cell receptors, B-cell receptor cell activation, complement system, Antigen processing and presentation, Regulation of immune response. **(4)**

7. **Immunological Techniques**: - Antigen- antibody reactions, Immuno-diffusion, Immunoelectrophoresis, ELISA, RIA, and Fluorescence activated cell sorter. **(4)**

8. **Immune System in Health and Disease:** Autoimmunity, Hypersensitivity, Tumor immunity, Tissue and organ transplant, Synthetic vaccines. **(6)**

9. **Production of Antibodies:** Production of polyclonal and monoclonal antibodies and their Applications. (**1)**

Text / Reference books:

1. Kuby- Immunology by R. A. Goldsby, T.J. Kindt, B.A. Osborne, 6th Edition 2006.
2. Essentials of Immunology: Ivan Riot- Blakswell Scientific Publications, Oxford, 6th Edition, 1988.
3. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988.

FOURTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT-204 MOLECULAR BIOLOGY

1. **Structure and Properties of Nucleic Acids:** Models of DNA structure, RNA structure, Physical and Chemical properties. **(2)**
2. **Eukaryotic Genome Organization and Complexity:** Packaging of DNA into chromosomes, C-value paradox, Cot analysis, Repetitive DNA content of eukaryotic nuclear genome. **(2)**
3. **Eukaryotic and Prokaryotic Organeller Genome:** Chromosome of prokaryotic gene organization, Origin of organelle genome, Physical features and genetic content**.** **(3)**
4. **DNA Replication: -** Models of DNA replication, Enzymology of DNA replication, Replication process: Initiation, Elongation and Termination of replication, Telomeres. **(3)**
5. **Transcription and Processing:** Components of transcriptional machinery in prokaryotes and eukaryotes, Transcription process: Initiation, Elongation and Termination of transcription, Capping and Polyadenylation, RNA Splicing and processing. **(5)**
6. **Translation: -** Genetic code, tRNA and aminoacyl synthetases, Ribosome, Translation process: Initiation, Elongation and termination of translation, Post translational modifications. **(5)**
7. **Regulation of Gene Expression: -** General aspects of regulation prokaryotes & eukaryotes: The operon models, Transcription factors, Transcriptional and Post-transcriptional gene regulation. **(5)**
8. **Gene Mutation:** Types of mutagens, Mutant types, Chromosome mutations, Changes in chromosome structure, Mutation and cancer, Molecular basis of gene mutation, DNA repair. **(6)**
9. **Molecular Evolution:** Phylogeny, Phylogenetic trees and its applications. **(3)**
10. **Epigenetics:** RNA interference process, Enzymatic machinery, Small RNA mediated gene regulation, DNA methylation, Enzymology and process, Gene silencing: transcriptional and post transcriptional gene silencing, History, process and applications. **(6)**

Text / Reference Books:

1. Gene VII by B. Lewin. Oxford Univ. Press Dec. 1999.
2. Essentials of molecular Biology, Malacinski and Freifelder.. Jones and Bartlelt Publishers, Edition 3, 1998.
3. Genomes, T. A. Brown, John Wiley and Sons PTE Ltd., Singapore, 1999.
4. Cell and molecular Biology, Concepts and experiments: Gerald Karp, John Wiley and Sons, 5th Edition.
5. The Cell - A molecular approach, GM Cooper. Asm Press Washington, 2nd Edition, 2000.

FOURTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT-206 ENZYME TECHNOLOGY

1. **Introduction to Enzymes:** What are enzymes, Brief history of enzymes, Nomenclature and classification of enzymes. **(3)**
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, Active site of enzyme. **(3)**
3. **Specificity of Enzymes**: Types of specificity, The Koshland "induced fit" hypothesis, Strain or transition – state stabilization hypothesis. (**3)**
4. **Enzyme Catalysis:** Mechanism of catalysis, Factors affecting catalytic activity, Mechanism of reaction catalyzed by enzyme without cofactors, Metal-activated enzyme and metalloenzyme, Coenzymes in enzyme catalyzed reactions. **(4)**
5. **Enzyme Kinetics**: Kinetics of enzyme-catalyzed reaction, Methods for investigating the kinetics of enzyme-catalyzed reactions, Interpretation of Km, Vmax, Turnover number and Kcat, Specific activity of enzymes, Enzyme units, Inhibition of enzyme activity, Regulation of enzyme activity. **(5)**
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. **(4)**
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, and Enzymes in organic solvent.**(4)**
8. **Industrial Enzymes: Proteases and Carbohydrases:** Proteolytic enzymes: Carbohydrases, Lignocellulose degrading enzymes, Pectin and Pectic enzymes. **(6)**
9. **Additional Industrial Enzymes:** Lipases, Penicillin acylase, amino acylase and Amino acid production, Cyclodextrins and cyclodextrin glycosyl transferase, Enzymes in animal nutrition, Enzymes in molecular biology. **(4)**
10. **Enzyme Engineering**: Prediction of enzyme structure, Design and construction of novel enzymes. **(4)**

Text / Reference Books:

1. Enzymes by Palmer: Horwood Publishing Series, 2001.
2. Fundamentals of Enzymology by Price and Stevens: Oxford University Press, 2002.
3. Enzymes in Industry: Productions and Applications by (Ed.) Wolfgang Aehle, WILEY-VCH Verlag GmbH & Co. KGaA. 2004.
4. Introduction to Proteins Structure by Branden and Tooze, Garland Publishing Group, 1998.
5. Proteins, Biochemistry and Biotechnology by Gary Walsh,John Wiley & Sons, Ltd, 2002.

FOURTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BA - 208 BIOENERGETICS – II

1. **Catabolism and the Generation of Chemical Energy:** Catabolism of carbohydrates, proteins, liquids and generation of chemical energy. **(6)**

2. **Metabolic Strategies:** General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis. **(5)**

3. **Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway:** Glycolysis, Gluconeogenesis, Regulation of glycolysis and Gluconeogenesis, the pentose Phosphate Pathway. **(6)**

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. **(7)**

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)**

6. **Photosynthesis and other Processes Involving Light*:*** Photosynthesis, Other Biochemical Processes Involving Light. **(5)**

7. **Metabolism of Fatty Acids:** Fatty Acid Degradation, Biosynthesis of Saturated Fatty Acids, Regulation of Fatty Acid Metabolism. **(5)**

Text / Reference Books:

1. Biochemistry by Lubert Stryer, W. H. Freeman & Company, NY, 4rd Edition, 1995.
2. Lehninger Principles of Biochemistry by Lehninger, nelson and Cox, W. H. Freeman & Company, 4th Edition, 2004
3. Biochemistry by Zubey. Wm. C., Brown publishers 4th edition, 1998.

FOURTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

CT-212 CHEMICAL ENGINEERING-II

1. **Steady State Conduction:** Fourier's law, Concept of resistance to heat transfer, Critical insulation thickness, Conduction with heat generation. **(5)**

2. **Convection:** Film theory and concept of heat transfer coefficient. Heat transfer by forced convection and natural connection in laminar and turbulent flows by dimensional analysis. **(6)**

3. **Heat Exchanger:** Sizing of shell and tube heat exchangers. Boiling and condensation heat transfer to boiling liquids and from condensing vapours. **(5)**

4. **Fundamentals of Mass Transfer**: Moleuclar diffusion in fluids, Concept of mass transfer coefficient. Equilirbium stage, Multistage and contious contactors with applications to gas absoption, Calculation of NTU, HTU and number of stages. **(20)**

5. **Mixing:** Types of agitators, Flow patterns and Power consumption. **(4)**

Course Objectives:

- To familiarize with unit operations utilized in downstream processes of biotechnology
- To introduce basic principles of heat transport
- To expose the students to heat transfer operations
- To introduce basic principles of man transport

Text / Reference Books:

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

UNIVERSITY SCHOOL OF BIOTECHNOLOGY

FIFTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-301 PLANT TISSUE CULTURE

1. **History:** Important events in the history of plant tissue culture. (2)

2. **Laboratory Requirements and General Techniques:** Introduction to plant tissue culture laboratory, tissue culture media, media constituents, media selection, media preparation. (3)

3. **Cellular Totipotency:** Introduction, cyto-differentiation, organogenic differentiation, loss of morphogenic potential in long-term cultures, practical applications of cellular totipotency. (3)

4. **Cell and Suspension Culture:** Introduction, isolation of single cells, suspension cultures, culture of single cells, plant cell reactors, applications of cell culture, production of secondary metabolites, strategies used to optimize product yield, commercial aspects. (4)

5. **Protoplast Culture:** Protoplast isolation, culture and regeneration. (3)

6. **Somatic Embryogenesis**: Introduction, some examples of somatic embryogenesis, factors affecting somatic embryogenesis, induction and development, maturation. (3)

7. **Haploid Production:** Introduction, techniques, factor affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos, gynogenesis, haploid production through distant hybridization to raise homozygous diploids, applications, limitations. (3)

8. **Triploid Production:** Introduction, callusing, histology and cytology of cells, organogenesis, applications of endosperm culture. (3)

9. **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, microsurgical experiments, embryo and seed culture of parasitic angiosperms, morphogenic potential of the embryo callus, practical applications. (3)

10. **In-vitro Pollination and Fertilization:** Introduction, terminology, in vitro pollination, in vitro fertilization, applications. Micropropagation a brief mention. (3)

Text / Reference Books:

- Bhojwani, SS. (2005). Plant Tissue Culture: Theory And Practice, 5th Revised Edition, Elsevier.
- Dodds, JH & Roberts, LW. (1995). Experiments in plant tissue culture. Cambridge University press, Cambridge.

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FIFTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT-303 MICROBIAL PROCESSING ENGINEERING

1. **Material Balances:** Thermodynamics Law of conservation of mass, types of material balance products, electron balances, biomass yield, theoretical oxygen demand., problems (**4)**
2. **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 (**4)**
3. **Unsteady State Material and Energy Balances:** Material balance equation for CSTR, Energy balance equations, solving differential equations, solving mass balances, solving energy balances, problems (**4)**
4. **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 (**5)**
5. **Heat Transfer:** Equipments, mechanism of heat transfer, conduction, heat transfer between fluids, design equation for heat transfer systems, applications of design equations, problems (**5)**
6. **Mass Transfer:** Molecular diffusion, role of diffusion in bioprocessing, film theory, convective mass transfer, oxygen uptake and transfer in cell cultures, kLa determination, problems. (**5)**
7. **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 (**4)**
8. **Heterogeneous Reactions:** Concentration gradients and reaction rates in solid catalysts, internal mass transfer and reaction, the Thiele modulus and effectiveness factor, external mass transfer, problems (**4)**
9. **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. (**5)**

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.

FIFTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT-305 Animal Biotechnology

1. **Introduction to Animal Tissue Culture:** Background, Advantages, Limitations, Application, Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation. (3)

2. **Design, Layout and Equipment:** Planning, Construction, Layout, Essential Equipments, Aseptic Technique, Objectives, Elements, Sterile Handling, Safety, Risk Assessment, General Safety, Fire, Radiation, Biohazards (5)

3. **Media:** Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media (5)

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)

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. (5)

6. **Contamination:** Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination (3)

7. **Cryopreservation:** Need of Cryopreservation, Preservation, Cell banks, Transporting cells (3)

8. **Cytotoxicity:** Introduction, In vitro limitations, Nature of assay, Viability assay, Survival assay, Microtitration assay, Transformation assay (3)

9. **Transgenic Animals:** Methodology, Embryonic Stem Cell method, Microinjection method, Retroviral vector method, Applications of transgenic animals (4)

10. **Applied Aspects of Animal Biotechnology:** In Vitro Fertilization and Embryo Transfer- Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA; Introduction to gene therapy: *ex vivo* versus *in vivo* gene therapy. (4)

Text / Reference Books:

1. Animal Cell Culture by John R.W. Masters Oxford University Press
2. Animal Cell Culture: A Practical Approach by R. Ian **Freshney**
3. Molecular Biotechnology: Primrose.
4. Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.

FIFTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-307 RECOMBINANT DNA TECHNOLOGY & APPLICATIONS

1. Basic concepts in genetic engineering (2)

2. **Tools of Genetic Engineering:** Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. (3)

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

4. **Methods of Gene Transfer:** Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, *Agro bacterium* mediated gene transfer. (3)

5. **Preparation and Application of Molecular Probes:** DNA probes, RNA probes, Radioactive labeling, Non radioactive labeling, use of molecular probes, DNA fingerprinting. (3)

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, Fusion proteins. (5)

7. **Gene Libraries** - cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, identifying the products of cDNA clones. (3)

8. **Isolation, Sequencing and Synthesis of Gene:** Different methods of gene isolation, Techniques of DNA sequencing, Artificial DNA synthesis. (3)

9. **Polymerase Chain Reaction (PCR):** Basic principles, modifications, applications.(3)

10. **Modifying Genes:** Site-directed mutagenesis, Insertion & Deletion Mutagenesis. (2)

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: A Laboratory Manual, Third Edition by Sambrook et al., 2001 Publisher: Cold Spring Harbor Laboratory Press
6. Principles of Gene Cloning by Old and Primrose.

UNIVERSITY SCHOOL OF BIOTECHNOLOGY

FIFTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT- 309 DEVELOPMENTAL 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. (4)

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

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

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. (3)

5. **Development of Nematodes, Cellular Slime Molds & Drosophila:** 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, role of zygotic , Pair rule, Segment polarity, Selector & Homeotic genes. (6)

6. **Morphogenesis:** Kinds of cleavage & blastulation, types of tissue movement in gastrulation, Gastrulation in amphibians & mammals, Neural tube formation & neural crest migration. (3)

7. **Cell Differentiation & Organogenesis:** Models of cell differentiation, Insect Imaginal disc & wing development. (3)

8. **Molting & Metamorphosis:** Amphibian metamorphosis, Insect metamorphosis. (3)

9. **Plant Development:** Pattern development in early embryogenesis of angiosperms, floral development. (3)

References:

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

2. Instant notes on Developmental Biology by Twyman

UNIVERSITY SCHOOL OF BIOTECHNOLOGY

SIXTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT-302 BIOINFORMATICS

1. **The Internet and Biologist:** Internet basics, FTP, Gopher, World Wide Web. (2)

2. **The Gen Bank Sequence Database & Structure Databases:** Introduction, Primary & Secondary database, Format vs content: computer vs humans, GenBank Flat File dissection, GCG, ACDEB, Introduction to structures, PDB, MMDB, Structure file formats, Visualizing structural information, Database structure viewers. (6)

3. **Information Retrieval from Biological Databases:** Retrieving database entries, Integrated information retrieval: The entrez system, sequence databases beyond NCBI, Medical Databases (3)
4. **The NCBI Database**: Introduction, SeqIDs, Bioseq: Sequences, Bioseqsets: Collections of sequences, Seq. Annot: Annotating the sequence, Seq discr: Describing the sequence (4)
5. **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 (4)

6. **Multiple Sequence Alignment**: Progressive alignment methods, Motifs and patterns, Hocks, MOST, Probe, Presentation methods, Abscript (4)

7. **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 (4)

8. **Predictive Methods Using Nucleotide Sequence & Predictive methods Using Protein Sequences:** Framework, marking repetitive DNA, Database search, Codon bias detection, Detecting function sites in the DM, Integrated gene passing, Finding tRNA genes,Protein identity based on composition, Propsearch, Physical properties based on sequences, secondary structure and folding classes, SSPREAD SOPMA, Specialized s tructures of features, Tertiary structure. (6)

9. **Genome Mapping:** Different types of maps: physical, genetical, etc. Synteny, Human genome project, Application of genome mapping, Chromosome maps.(4)

10 **Submitting DNA Sequences to the Databases**: Introduction, Where to submit, What to submit, How to submit on the world wide web, How to submit with sequin. (3)

Text / Reference 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.

SIXTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-304 FOOD BIOTECHNOLOGY

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

2. **Taxonomy:** Role and significance of microorganisms in foods. Intrinsic and Extrinsic Parameters of Foods that affect microbial growth. (3)

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

4. **Starter Cultures**, cheese, beer, wine and distilled spirits, SCP, medical foods, probiotics and health benefits of fermented milk and foods products. (3)

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. (3)

6. **Nutritional Boosts and Flavor Enhancers:** Emerging processing and preservation technologies for milk and dairy products. (3)

7. Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods (3)

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. (5)

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. (3)

10. **Psychrotrophs:** Thermophiles and Radiation-resistant Microorganisms, Characteristics and Growth of Thermophilic Microorganisms, Nature of Radiation Resistance in Microorganisms. Rheology of Food Production, Consumer perspective and future of food biotechnology. (3)

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.

SIXTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-306 PLANT BIOTECHNOLOGY

1. **Introduction:** Definition, Classical vs modern approach. (2)

2. **Micropropagation and production of disease free plants:** Basic technique, Automation in the area scope as an commercial venture, variety of explants: shoot tip culture, shoot tip grafting, viricidel compounds (3)

3. **Tissue Culture as some of Genetic Variability:** Somaclonal and gametoclonal variation, Selection, Sources and causes of variation, Application in crop improvement. (3)

4. **Protoplast Related Techniques:** Protoplast, Isolation, Culture and fusion, Selection of hybrid cells, regeneration of hybrid plants, somatic hybridization and cybridization, Applications in crop improvement. (3)

5. **Plant as Biofactories:** Concept, Production of Chemicals, Pigments, Perfume, Flavors, Insecticides, anticancer agents and other important compounds. (3)

6. **Transformation Techniques:** Physical methods, *Agrobacterium*, Mediated transformation (3)

7. **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. (4)

8. **Nitrogen Fixation:** Basic concepts, nif genes and their regulation, potential scope in crop improvement (3)

9. **Transformation of Organelles:** Methods and success, advantages of organeller transformation. (3)

10. **Molecular Markers** Concept, SNPs, RAPD, RFLP, ISSR, STMS, role in crop improvement and genome mapping. (3)

Text / Reference Books:

1. Bhojwani, SS. (2003). Agrobiotechnology and Plant Tissue Culture. Oxford University Press.
2. Slater, S, Scott, NW & Fowler, MR. (2008). Plant Biotechnology: the genetic manipulation of plants, second edition, Oxford.

SIXTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

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. (6)

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. (5)

3. **Proteins from Microbes:** Recombinant versus non-recombinant proteins, Microorganisms as source of proteins, Protein production in genetically engineered microorganism such as E. coli, yeast and fungi. (5)

4. **Proteins from Plants:** Proteins from plants, Production of heterologous proteins in plants. (4)

5. **Proteins from Animal:** Animal tissues as protein source, production in transgenic animals, animal cell culture, insect cell culture. (4)

6. **Large Scale Protein Purification:** Production of factor VIII, t-PA, hepatitis B, Asparaginase, insulin, interferon alfa, glucose oxidase, horse radish peroxidase, Alfa amylase, subtilisin, lipase, casein, whey protein concentrate. (5)

7. **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. (5)

8. **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). (6)

Text / Reference 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.

SIXTH SEMESTER EXAMINATION

	L	T	C	Hours
	2	1	3	30

BT-310 BIOSENSOR

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

Text / Reference Books:

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

SEVENTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-312 Biochemical Engineering & Biotechnology (Elective for Chemical Technology Students)

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. (3)

2. **Amino Acids, Peptides and Proteins:** Structure, Function, Methods of Characterization, Separation Techniques based on their structure and properties. (2)

3. **Nucleic Acids:** Nucleic Acids and Polynucleotides, Classification, Structure, Function, Separation and Characterization Techniques. (2)

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. (3)

5. **Metabolic Strategies:** General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis. (3)

6. **Bioprocess/fermentation technology:** Bioreactor, Scale-up, Media design, Technology for microbial, mammalian and plant cell culture, downstream processing. (3)

7. **Enzyme Technology:** Nature, Application, Genetic engineering & protein engineering, Immobilised enzymes and Technology of enzyme production. (3)

8. **Biopharmaceuticals:** Introduction to genetic engineering, Antibiotics, Therapeutic proteins, Vaccines & monoclonal antibodies, Gene therapy. (3)

9. **Food and beverage technology:** Introduction, Fermentation, Food processing, Sweeteners, Food wastes, Rapid diagnostics, Public acceptance & safety. (3)

10. **Agricultural and forestry Biotechnology:** Introduction, Plant biotechnology, Forestry, Biological control, Animal biotechnology, Diagnostics in agriculture, Bioremediation. (3)

11. IPR, Safety, Social, moral and ethical aspects of Biotechnology. (2)

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

SEVENTH SEMESTER EXAMINATION

	L	T	C	Hours
	3	1	4	40

BT-401 STEM CELLS IN HEALTH CARE

1. **Introduction**: Stem Cell Biology, Fate Mapping of Stem Cells. (4)
2. **Stem Cell Pattern:** Differentiated Parental DNA Chain Causes Stem Cell Pattern of Cell-type switching in *Schizosaccharomyces pombe.* *(*3)
3. On Equivalence Groups and the Notch/LIN-12 Communication System. (4)
4. Cell Cycle Control, Checkpoints, and Stem Cell Biology, Senescence of Dividing Somatic Cells. (4)
5. **The Drosophila Ovary**: An In Vivo Stem Cell System. (5)
6. Male Germ-line Stem Cells. **(**4)
7. Primordial Germ Cells as Stem Cells, Embryonic Stem Cells, Embryonal Carcinoma Cells as Embryonic Stem Cells, Trophoblast Stem Cells. (4)
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. (4)
9. Mesenchymal Stem Cells of Human Adult Bone Marrow, Stem Cells and Neurogenesis. (4)
10. **Epidermal Stem Cells:** Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon. (4)

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.

SEVENTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

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. (3)

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)

3. **Solid Waste Management:** Landfills, composting, earthworm treatment, recycling and processing of organic residues. (2)

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. (4)

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. (3)

6. **Microbial Leaching and Mining:** Extraction of metals from ores; recovery of metals from solutions; microbes in petroleum extraction; microbial desulfurization of coal. (3)

7. **Environmental Biotechnology in Agriculture:** Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides (3)

8. **Biofuel**: Plant derived fuels, energy crops, biogas, bioethanol, biohydrogen (3)

9. **Environmental genetics**: Degradative plasmids, release of genetically engineered microbes in environment. (3)

10. Biosafety and bioethics in Biotechnology, environmental laws and policies. (3)

Text / Reference Books:

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

SEVENTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-405 PROTEIN BIOTECHNOLOGY

1. **Protein Structure:** Introduction, Overview of protein structure, higher level structure, Protein post-translational modification, Protein stability and folding. (2)

1. **Protein Sources:** Introduction, Microorganisms as sources of proteins, Proteins from plants, Animal tissue as a protein source, direct chemical synthesis, Conclusion. (3)

2. **Protein Purification and Characterization:** Introduction, Initial recovery of proteins, Removal of whole cells and cell debris, Concentration and primary purification, Column chromatography, Protein inactivation and stabilization, Protein characterization. (4)

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. (3)

4. **Therapeutic Proteins:** Introduction, Blood products, Haemophilia A and B, Anticoagulants, Thrombolytic agents, Additional blood-related products, Vaccine technology, Vaccines for AIDS (3)

5. **Therapeutic Antibodies and Enzymes:** Introduction, Antibodies for in vivo application, Therapeutic enzymes. (3)

6. **Hormones and Growth Factors used Therapeutically:** Introduction, Insulin, Glucagon, Gonadotrophins, Growth hormone, Erythropoietin, Other growth factors, Thyrotrophin, Corticotrophin, Prolactin, Peptide Regulatory Factors. (3)

7. **Interferons, Interleukins and Additional Regulatory Factors:** Regulatory factors; cytokines versus hormones, Interferons, Interleukins, Tumour necrosis factors, Colony-stimulating factors, Cytokine toxicity. (3)

8. **Proteins used for Analytical Purposes:** Introduction, Enzymes as diagnostic/analytical reagents, Biosensors, Antibodies as analytical reagents. (3)

9. **Non-catalytic Industrial Proteins:** Introduction, Functional properties of proteins, Milk and milk proteins, Animal and microbial proteins, Sweet and taste modifying proteins. (3)

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.

SEVENTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

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. (5)

2. Creating and marketing the image of the biotechnology Company. Art of negotiation & effective communication. (5)

3. Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up. (5)

4. How to portray management and role of a biotechnology manager, technology decision-making, and resource decision-making etc., Product marketing decision. (5)

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

6. Positioning, power and importance of positioning of a company name and product, Workable marketing and the strength of distribution. (5)

7. Effective advertising and marketing. Opportunities international, marketing and lessons to be learned. (5)

8. Indian and foreign prospective of biotechnology, and current challenges for the biotechnology based products. (5)

Text / Reference Books:

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.

SEVENTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

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 and 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.

EIGHTH SEMESTER EXAMINATION

L	T	C	Hours
3	1	4	40

BT-402 INDUSTRIAL BIOTECHNOLOGY

1. Introduction, Objectives and Scope; Characteristic and comparison of bioprocessing with chemical processing. (5)

2. Substrates for bioconversion processes and design of media (5)

3. Isolation, preservation and improvement of industrial microorganisms, Cell culture techniques and aseptic transfers (5)

4. Metabolic basis for product formation. Production of secondary metabolites-penicillin, tetracycline etc (5)

5. Process technology for the production of cell biomass and some primary metabolites, e. g. ethanol, acetone-butanol, citric acid, dextran and amino acids. (4)

6. Microbial production of industrial enzymes-glucose isomerase, cellulase & lipases. (4)

7. Applications of bioconversion, transformation of steroids and sterols. Transformation of non-steroidal compounds, antibiotics and pesticides. (4)

8 Bioenergy-fuel from biomass, production and economics of biofuels. (4)

9. Metal recovery and microbial desulfurization of coal. (4)

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, Hyderabd, 2003

EIGHTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-404 INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY

1. **Introduction to IPR:** As an international agency controlling trade among nations. WTO with reference to biotechnological affairs, TRIPs. (3)

2. **Introduction to Patents:** Patent claims, the legal decision – making process, ownership of tangible and intellectual property. (4)

3. **Basic Requirements of Patentability:** Patentable subject matter, novelty and the public domain, non obviousness. (4)

4. **Special issues in Biotechnology Patents:** Disclosure requirements, Collaborative research, Competitive research, plan (4)

5. **Plant biotechnology:** Plant patents and Utility patents, Plant variety protection act, the strategy of protecting plants. (3)

6. **Patent Litigation:** Subtractive aspect of patent litigation, Procedural aspects of patent litigation, different Doctrines (3)

7. Recent Developments in Patent System and Patentability of biotechnological inventions. (3)

8. **IPR issues in Indian Context** Role of patent in pharmaceutical industry, computer related innovations (3)

9. **Case studies:** Rice, Haldi, Neem, etc. and challenges ahead (3)

Text / Reference Books:

1. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
2. Intellecutla property rights – Ganguli – Tat McGrawhill
3. Intellectual property right – Wattal – Oxford Publishing House.

EIGHTH SEMESTER EXAMINATION

L	T	C	Hours
2	1	3	30

BT-406 MOLECULAR AND CELLULAR DIAGNOSTICS

1. **General Clinical Laboratory Techniques & Procedure:** Chemical & Related substrates, Balancing & Weighing, Concept of solute & solvent, Units of measurement (3)

2. **Specimen Collection & Processing:** Specimen collection (Blood, urine, spinal fluid, saliva synovial fluid, Amniotic fluid), Preservation, transportation (3)

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

4. **Quality Management:** Fundamentals of total quality management, Element of QAP, External quality assessment. (3)

5. **Clinical Enzymology:** Principle of diagnostic enzymology, Liver, cardiac and skeletal enzyme, Digestive enzyme, Miscellaneous enzyme (3)

6. **General Function Tests:** Liver function test, Cardiac Function Test, Renal Function Test, Thyroid Function test, endocrine function test, Glucose tolerance test (3)

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. (3)

8. **Product Development:** Immunoassay Classification and Commercial Technologies, Assay Development, Evaluation, and Validation, Reagent Formulations and Shelf Life Evaluation. (3)

9. **DNA based diagnostics:** PCR, RFLP, SSCP, Micro-arrays, FISH, In-situ hybridization, Case studies related to bacterial, viral and parasitic infections. (3)

10. **Cell based diagnostics:** Antibody markers, CD Markers, FACS, HLA typing, Bioassays. Biosensors and nanotechnology. (3)

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.

EIGHTH SEMESTER EXAMINATION

L	T	C	Hours
2	0	2	30

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, globalization and development divide. (3)
2. **Bioethics**: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. (2)
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. (2)
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. (3)
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. (4)
6. **Biosafety regulations** in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad. (3)
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. (3)
8. **Ecological safety assessment** of recombinant organisms and transgenic crops, case studies of relevance (e.g. Bt cotton). (3)
9. Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc. (3)
10. **International dimensions in biosafety**: Catagena protocol on biosafety, bioterrorism and convention on biological weapons. (4)

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