

M.Sc. INDUSTRIAL BIOTECHNOLOGY**I SEMESTER****Core:**

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IBT – 401: Molecular Biology

IBT – 402: Bioinstrumentation

IBT – 403: Chemical Engineering & Thermodynamics of Biological Systems

Optional:

IBT – 404:

Cell biology and Genetics

Phytoresource utilization and conservation

Microtechniques

Pharmacognosy

IBT – 405: Practicals of IBT – 401 and IBT – 402

IBT – 406: Practicals of IBT – 403 and IBT – 404

IBT – 407: Viva – voce

II SEMESTER**Core:**

IBT – 501: Bioprocess & Biochemical Engineering

IBT – 502: Transport processes & Downstream processing

IBT – 503: Genetic engineering & Bioinformatics

Optional:

IBT – 504:

Biostatistics

Phytoresource utilization and conservation

Microtechniques

Pharmacognosy

Human physiology

IBT – 505: Practicals of IBT – 501 and IBT – 502

IBT – 506: Practicals of IBT – 503 and IBT – 504

IBT – 507: Viva – voce

I SEMESTER

IBT 401 MOLECULAR BIOLOGY

Unit I

DNA Structure: Chemistry of DNA, Forces stabilizing DNA structure, Helix parameters, Forms of DNA (A,B,C,D,T and Z), Watson – Crick and Hoogsteen base pairing, Physical properties of ds DNA (UV absorption spectra Denaturation and renaturation, cot curves, DNA hybridization), Chemical that react with DNA. **DNA topology:** DNA supercoiling, Supercoiled form of DNA, Superhelical density, energetics of supercoiled DNA, Biology of supercoiled DNA (Topological domain of DNA, DNA topoisomerases, Mechanisms of supercoiling in cells, mechanisms of action of topoisomerase I and II, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication).

Unit II

Organization of DNA into chromosomes: Packaging of DNA and organization of chromosome in bacteria and eukaryotic cells; packaging of DNA in eukaryotic nucleosome and chromatin condensation assembly of nucleosomes upon replication. Chromatin modification and genome expression. **DNA – Protein Interactions:** General features interaction of Helix- turn Helix motif, B-sheet, Zn- DNA binding domain etc with DNA.

Unit III

DNA Replication: Mechanism of DNA polymerase catalyzed synthesis of DNA, types of DNA polymerases in bacteria and their role. Initiation of chromosomal DNA replication and its regulation in prokaryotes assembly of replisome and progress of replication fork, termination of replication. Types and function of eukaryotic DNA polymerases initiation of replication in eukaryotes, role of telomerases in replication of eukaryotic chromosomes. Inhibitor of DNA replication (Blocking precursor synthesis nucleotide polymerization, altering DNA structure).

Transcription: RNA polymerases, features of prokaryotic and eukaryotic promoters. Assembly of transcription initiation complex in prokaryotes and eukaryotes and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts. Transport of RNA within eukaryotic cell. **Amino acid metabolism:** Biosynthesis and catabolism of amino acids and its regulation.

Unit IV

Synthesis and Processing of Proteome: Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Posttranslational processing of protein (protein folding, processing by proteolytic cleavage, processing by chemical modification, inteins). Protein degradation.

Unit V

Regulation of Gene expression in prokaryotes and eukaryotes: Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination, global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

References

Genomes: T A Brown

Genes IX: Lewin

Molecular biology of gene: Watson et al Vth edition.

Molecular genetics: Stent and Calendar.

Molecular biology of Cell: Alberts et al.

Molecular Cell Biology VIth edition: Lodish et al

IBT: 402- BIOINSTRUMENTATION

Unit I

Electrochemistry: pH and buffers, potentiometric and conductometric titration. Principle and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy, cytophotometry and flow cytometry. Preparation of microbial, animal and plant samples for microscopy.

Unit II

Principle methodology and applications of gel – filtration, ion –exchange and affinity chromatography; Thin layer and gas chromatography; High performance liquid chromatography, FPLC.

Unit III

Centrifugation: Basic principle and application; Differential, density and Ultracentrifugation. Principle of biophysical method and used for analysis of biopolymer structure; X ray diffraction, fluorescence,

Unit IV

Spectroscopy : UV, visible, IR, NMR and ESR spectroscopy. Atomic absorption and plasma emission spectroscopy; MS and MALDI-TOF. Electrophoresis: Principle and applications of Native, SDS, Agarose and 2D gel electrophoresis.

Unit V

Principle and applications of tracer technique in biology: Radioactive Isotopes and half life of isotopes; Effect of radiation on biological system; autoradiography; cerenkov radiation; radiation dosimetry; scintillation counting. Biosensors: Principle and application

Reference Books:

Shrama BK, Instrumental method of chemical analysis

DA Skoog. Instrumental methods of analysis

Plummer, An introduction to practical Biochemistry

Chatwal and Anand, Instrumentation

IBT 403: Chemical Engineering & Thermodynamics of Biological systems**Unit I**

Fundamental of fluid mechanics: Properties of fluids, fluid static, pressure measurement, forces on submerged bodies equation of continuity and motion, Bernoulli's equation and its application. Newtonian and Non-Newtonian fluids, Laminar and Turbulant flows, Pressure drop calculation and friction factor. Measuring and control of flowing fluids, principles and operation of variables, head meter and variable area meter. Fluid moving machines such as pumps, blowers, compressors, vacuum system.

Unit II

Fundamentals of heat transfer:

Steady state conduction-Fourier law, Concepts of resistance to heat transfer, heat transfer coefficient, Insulation, critical radius.

Unit III

Convection- Free and forced convection, temperature gradient in forced convection, LMTD, dimensional analysis.

Heat transfer equipments-heat exchangers, heat transfer to boiling liquids, condensation.

Unit IV

Elementary concepts of unit operations and unit processes, flow sheet preparation, concept of mass balance and types of mass balance problems, strategy without and with chemical reactions. Recycle operation and purge operation, by pass operation. Calculations based on above topics.

Unit V

Fundamentals of Thermodynamics of biological systems:

First and second laws of thermodynamics, Activity coefficients and phase equilibrium, Biological systems as open, non-equilibrium system, Failure of classical (closed, equilibrium) thermodynamics in describing biological processes, Thermodynamics concepts for irreversible biological process, Concepts of thermodynamics flux and force, Concept of entropy production, Constitutive equations, Onsager reciprocal relations, Prigogine's principle, Concept of coupling in biological processes, Thermodynamics of coupled biochemical reactions, Cells as non-equilibrium stationary states, Non-equilibrium thermodynamics of passive and active transport, Prigogine-Curie law, Thermodynamic analysis of oxidative phosphorylation, stability of non-equilibrium stationary stages, ordering in time and biochemical engineering and biotechnology, Space far from equilibrium, Glycolytic oscillations, Biological clocks, Routes to Chaos.

Reference books:

Stoichiometry: B L Bhatt & Vora S M., Tata McGraw Hill.

Chemical process calculations (Stoichiometry): K A Gavhane, Nirali prakashan, Pune.

Introduction to chemical engineering: Walter L Badger & Juline T Banchemo (McGraw Hill).

Unit operation of chemical engineering: Warreh L McCabe & Jullian L Smith, McGraw Hill.

Chemical Engineering (Vol. I & II): J M Coulson & K F Richardson, Asian Books Pvt. Ltd., New Delhi.

IBT 404: CELL BIOLOGY & GENETICS**UNIT-I**

An overview of Cells and Cell Research; Structure and Organization of pro-and eukaryotic cells.

Applications of electron microscopy in Cell biology; Transmission and Scanning electron microscopes: components and principle of image formation; Cell membranes: freeze fracturing and freeze etching of cellular membranes, molecular organization, Cell permeability - transport across membranes: facilitated diffusion, active transport and receptor mediated endocytosis.

UNIT-II

Nucleus – Structure of the nuclear envelope, organization and regulation of nuclear pore complex. Transport across nuclear membrane, internal organization of the nucleus and nucleolus, the nucleus during mitosis. Chloroplast and Mitochondria: similarities and dissimilarities, structural organization in relation to function, genome, transport of metabolites across the membranes, import and export of proteins through membrane compartments and biogenesis – Envelope, stroma and thylakoids; Molecular organization of thylakoids; Endomembrane system: endomembrane concept, membrane flow, Structural organization of ER and Golgi, targeting of proteins to ER, , insertion of proteins into ER membrane, Protein folding and exporting of proteins and lipids from ER to golgi protein sorting and export from golgi to different cellular compartments, mechanism of vesicle transport and vesicle fusion..

UNIT-III

Cytoskeletal elements– composition and organization of microtubules, microfilaments and intermediate filaments. Role in cell division, wall formation and transport.

Intercellular communications: Cell wall –structure, composition, function and biogenesis.

Plasmodesmata, Tight junctions, Gap junctions – Structure and role in movement of molecules.

Cell Cycle – Phases of Cell Cycle, functional importance of each phase, Molecular events during cell cycle, Check points, Cyclins and protein kinases, MPF (maturation promoting factor), Regulation of cell cycle.

UNIT-IV

Fundamentals of Genetics: Mendelian analysis, Mendel's Laws of Inheritance, The principle of

segregation, Test cross and back cross; The principle of Independent assortment, pedigree analysis. Probability & Statistics in Genetics: Probability in genetic analysis; probability of combination of events, mutually exclusive events, use of binomial distribution in Genetics; The Chi-square goodness of fit test and its use in Genetics. Interaction of genes: Incomplete dominance, co-dominance, lethal genes, epistasis, pleiotropy polygenic traits and quantitative inheritance; Sex chromosomes and sex-linked inheritance: Transmission of sex-linked traits, sex determination; Linkage and chromosome mapping and its significance: Linkage, Crossing over- two point crosses, three –point crosses tetrad analysis, chromosome maps.

UNIT-V

Maternal effects and cytoplasmic inheritance: Maternal effects in snails, Streptomycin resistance in *Chlamydomonas*, mitochondrial mutations in yeast, Kappa particles in paramecium, plastid inheritance in *Mirabilis jalapa*, male sterility in plants; Alterations in chromosome number and structure: Ploidy: Aneuploidy and euploidy, polyploidy and its significance: alteration in chromosome structure: Deletions, duplications, inversions and translocations; Mutations: Types of mutations, mutagens, molecular basis of mutations; transposable elements; Reverse mutations & suppressor mutations.

Reference Books:

- Cell and Molecular Biology (1987), 8th Edn. De Robertis, E. D. P. and De Robertis, E. M. F. Jr., Lea & Febiger, USA (Indian Edn.: K. M. Varghese Company, Bombay).
- Essential Cell Biology – Second Edition (2004), Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter, Garland Publishing Inc., New York.
- Molecular Biology of the Cell (2002) Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson, Garland Publishing Inc., New York.
- Cell and Molecular Biology: Concepts and Experiments (1996) Gerald Karp, John Wiley & Sons, Inc., USA.
- Cell and Molecular Biology (2002), Phillip Sheeler and Donald E. Bianchi, John Wiley & Sons, Inc, Canada (Indian print by Replika Press Pvt. Ltd., Kundli).
- The world of the Cell – Fourth Edition (2000) Wayne M. Becker, Lewis J. Kleinsmith and Jeff Hardin, Addison Wesley Longman, Inc. (Benjamin/Cummings Imprint).
- The Cell – A Molecular Approach (Third Edition) (2004) Geoffrey M. Cooper and Robert E. Hausman, ASM Press, Washington, D. C.
- Molecular Cell Biology (1986) Avers. C.J., Addison-Wesely Publishing Co., Inc., New York, USA.
- Molecular Cell Biology 3rd edn, (1995) Lodish, Baltimore, Berk, Lawrence, et al, Scientific American Books, N.Y.
- Biochemistry and Molecular Biology of Plants (2000) Eds. Buchanan, Grissem and Jones, American Soc. Plant Biologists, Waldorf.
- Genes (2000), edn7, Lewin B, Oxford Univ. Press, Oxford.
- Cell Biology: A Laboratory Handbook- Third Edition. Volumes 1 – 4 (2006), Edited by Julio E. Celis, Elsevier Academic Press, U. K.
- David. E. Sadava. 1993. Cell Biology. Jones and Bartlett Publishers, Boston.
- Strickberger M. W. Genetics. Third Edition. Macmillan Publishing co. New York.
- Robert Weaber & Philip W. Hedrick. Basic Genetics, Second Edition. W. M. C. Brown Publishers Dubuque lowq.
- Anna C. Pai & Helen M. Roberts. Genetics – its concepts & implications, Prentic – Hall Inc. Engle

clifts, New Jersey. USA

- Edmund W. Sinnott, L. C. Dunn & T. Dobzhansky, Principles of Genetics. McGraw Hill Book company Inc. New York, USA.
- M. Sr & R. W. Owen. General Genetics, W. H. Freeman & Company, Sanfrancisco.
- P. K. Gupta, Genetics. Rastogi Publications. Shivaji Road Meerut, India.

IBT – 405: Practicals of BT – 401 and BT – 402

IBT – 406: Practicals of BT – 403 and BT – 404

IBT-407 VIVA VOCE

SEMESTER II

BT 501: BIOPROCESS AND BIOCHEMICAL ENGINEERING

Unit I

Introduction to bioprocess technology

Isolation, preservation and improvement of industrially important organisms.

Substrates for fermentation processes

Medium optimization

Unit II

Elements of biochemical engineering:

Bioreactor design: Laboratory, pilot and large scale reactors. Plug flow reactors, enzyme reactors.

Sterilization of media and air

Mass transfer of oxygen: Agitation and aeration, Determination of K_La , factors affecting K_La , fluid rheology. Inoculum development, aseptic inoculation and sampling.

Unit III

Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems.

Unit IV

Control of process parameters: Instrumentation for monitoring bioreactor and fermentation processes, Sensors, Controllers, fermentation control systems and architecture, Incubation and sequence control, advanced control. Dynamic modeling of fermentation processes

Unit V

Immobilization of Enzymes and cells. Downstream processing: Methods of Cell separation, Disruption and product purification.

Reference Books

Principles of Fermentation Technology : Whitekar & Stanbury
Comprehensive Biotechnology : Murray Moo Young
Methods in Industrial Microbiology : Sikyta
Fermentation Microbiology and Biotechnology, El Mansi and Bryc

IBT-502: TRANSPORT PROCESSES & DOWN STREAM PROCESSING.

Unit I

Fundamentals of Mass transfer:

Molecular and convective mass transfer, diffusivity and mass transfer coefficients, convective and interface mass transfer, basic equations for diffusion mass transfer in binary system.

Unit II

Mass transfer equipments

Distillation, Absorption and adsorption equipments, Crystallization, drying, liquid Extraction.

Unit III

Transport processes

Introduction to transport phenomenon, transport properties, system and control of volume. Development of velocity, temperature and concentration profiles, overall mass transfer, momentum and energy balances. Differential mass, momentum and energy balances. Steady and unsteady state heat conduction. Turbulent transport mechanism and analysis of mass, momentum and energy transfer. Momentum, energy and mass transfer analogies.

Unit IV

Mechanical Operations:

Filtration and filtration equipments. Centrifugation-centrifugal separation, settling and sedimentation. Mixing problems and mixing equipments, mechanical size reduction and size separation

Unit V

Down stream processing:

Characteristics of bioproducts
locculation and conditioning of broths
Cell disruption and cell separation by filtration and centrifugation
Ultrafiltration, crystallization, drying, evaroparotion
Liquid-liquid extraction of antibiotics and biopolymers, Aqueous two phase extraction
Ion exchange, molecular sieve, affinity chromatography, hydrophobic interactions, HPLC, membrane based separations, distillation, dialysis and reverse dialysis
Precipitation and separation of proteins, protein purification from recombinant strains
Electrophoresis and electro dialysis, Case studies.

Reference Books:

1. Fundamentals of momentum, heat and mass transfer-James (Charles & Robert, John Wiley & Sons).
2. Transport phenomenon-Robert & herry (Mc Graw Hill)
3. Elements of transport phenomena- Leighton & Donald (Mc Graw Hill)
4. Transport processes & unit operations- Christie J Gearikoplis (Prentice Hall, India)
5. Mass transfer-Patil (Nirali Prakashan)
6. Engineering heat transfer-Gupta & Prakash
7. Fundamentals of engineering heat and mass transfer-R C Sachdev.

IBT-503: GENETIC ENGINEERING & BIOINFORMATICS

Unit I

Genetic Engineering

Introduction to the scope of genetic engineering. Overview of the principles and progress in genetic engineering.

Basic steps involved in recombinant DNA technology: Isolation of DNA from various sources, fragmentation methods, ligation strategies, introduction of the chimeric DNA into various host cells and selection and screening of recombinant clones.

Unit II

Manipulation and characterization of cloned DNA: Basic PCR, Reverse Transcriptase, inverse, nested, real time and mega primer PCR.

Unit III

DNA sequencing and sequence assembly. Maxam-Gilbert's and Sanger's methods, Shot gun sequencing, sequencing strategies for large genomes.

DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting.

Site directed mutagenesis: Methods and applications.

Unit IV

Bioinformatics

Introduction to Bioinformatics:

Overview, Internet and bioinformatics, Applications

Databases: Databases in Bioinformatics, various biological databases, Protein and Nucleotide sequence Data bases. Protein sequence, structure and Classification databases

Sequence analysis:

Pairwise alignment, local and global alignment, Multiple sequence alignment,

Gene prediction: Gene prediction methods: Signal sites Predictions

Unit V

Protein Computational Biology:

Structural classification of proteins, structure alignment and comparison and Protein

Structure prediction, Active site prediction, Protein modeling and drug design

Phylogenetic analysis: molecular basis of evolution, Phylogenetic trees & different methods for phylogenetic inference

Reference Books:

Bioinformatics: A Beginners Guide, Clavarie and Notredame

Bioinformatics: David Mount

Bioinformatics: Rastogi

Introduction to Bioinformatics: Arthur M. Lesk

M.Sc. Biotechnology Syllabus w.e.f. June 2009 (I-IV Semesters)

Bioinformatics: Principles and applications, Ghosh and Mallick

Bioinformatics: Genes, Proteins and Computer, C A Orengo

Protein Structure Prediction: Methods and Protocols, Webster, David (Southern Cross Molecular Ltd., Bath, UK)

IBT- 504: BIOSTATISTICS**Unit I:****Data Collection and Presentation**

Types of Biological Data: Qualitative Data -Nominal, Ordinal, Ranked; Quantitative Data: Discrete and Continuous.

Understanding of Population and sample

Methods of Collection of Data: (i) Experimental Data and (ii) Survey Data- Simple random sample(with and without replacement), stratified sampling and cluster sampling.

Tables: Frequency Distributions, Relative Frequencies.

Graphical Presentation: Bar charts, Histograms, Frequency Polygons, One way scatter plots, Box plots, two-way scatter plots, line graphs.

Practicals Using MS-Excel.

Unit II:**Descriptive Statistics**

Measures of Central Tendency: Mean, Median and Mode, quartiles, deciles and percentiles (both for raw data and grouped data)

Measures of Dispersion: Range, Interquartile Range, Variance, Standard Deviation and Coefficient of Variation.

Measures of Skewness and Kurtosis.

Practicals Using MS-Excel.

Unit III:**Probability and Probability Distributions:**

Random Experiment: Elementary outcomes, events, and Sample Space.

Mathematical Definition of Probability, Marginal Probability, Marginal Probability and Conditional Probability. Independent Events. Some simple laws of probabilities(Statements only).

Random Variables: Discrete and Continuous. Some examples from biological sciences.

Probability Distributions: Binomial Distribution, Standard Normal Distribution, General Normal Distribution; Sampling Distributions- t, chi-square and F distributions.

Unit IV:**Testing of hypotheses:**

Statistical hypotheses: Null and Alternative hypotheses. Simple and Composite hypotheses.

Statistical Tests: Acceptance region and Rejection Region. Types of errors and power of the test.

Goodness of fit tests.

Significance Tests for Normal Distribution: One sample tests for mean – z test and t-test.

Two sample tests for normal distributions: Tests for means (i) when variances are known (ii) when variances are unknown. Tests for equality of variances.

Paired t-test for equality of means.

Confidence Intervals

Practicals using MSEXCEL.

Unit V:**Bivariate and Multivariate Data**

Some examples on bivariate and multivariate data. Correlation: Simple, partial and multiple correlation Coefficients.

Regression: Simple and multiple linear regressions. Logistic Regression

Analysis of Variance: Completely Randomized Design, Randomized Block Design

Practicals Based on SPSS

IBT – 505: Practicals of IBT – 501 and IBT502

IBT – 506: Practicals of IBT – 503 and IBT – 504

IBT-507 VIVA VOCE**M.Sc. INDUSTRIAL BIOTECHNOLOGY****III SEMESTER****Core:**

PS03CIBT01: Microbial Biotechnology

PS03CIBT02: Immunology

PS03CIBT03: Enzymology

Elective:

PS03EIBT01: Human physiology

Cell Biology & Genetics

Biostatistics

PS03CIBT04: Practicals of PS03CIBT01 and PS03CIBT02

PS03CIBT05: Practicals of PS03CIBT03 and PS03EIBT01

PS03CIBT06: Viva voce

IV SEMESTER**Core:**

PS04CIBT01: Animal & Plant Biotechnology

PS04CIBT02: Environmental Biotechnology
 PS04CBIT03: Practicals of PS04CBOT01 and PS04CBOT02
 PS04CIBT04: Dissertation
 PS04CIBT05: Viva voce

III SEMESTER

PS03CIBT01: Microbial Technology

General concept of Microbial biotechnology

Fermentation economics

Microbial production of.....

Antibiotics: penicillin, streptomycin

Enzymes: proteases, amylases

Organic acids: Citric acid, acetic acid

Vitamins: Vit B12, B2

Amino acids: Glutamic acid, Lysine

Ergot Alkaloids

Industrial Alcohol,

Beer and wine

Microbial Exopolysaccharides: Xanthan, Alginate

Single cell protein from bacteria, fungi and algae. Nutritional value and safety.

Single cell oil

Microbial Flavours: Diacetyl, Methyl ketones, Terpenes, Vanillin

Fermented food and dairy products: Starter cultures, science and technology of bread, cheese and yogurt manufacture.

Edible Mushrooms: Cultivation of edible and medicinal mushrooms.

Bioplastics.

Biotransformations of steroids.

Reference Books :

Biotechnology : Rehm and Reid.

Comprehensive biotechnology : Murray Moo Young.

Microbial Technology: Pepler

Microbiology and technology of fermented foods: R. W. Hutkins. Blackwell publishing.

Topic related review papers

PS03CIBT02: Immunology

Innate and adaptive immunity: role of cells, receptors and proteins in innate immunity, ubiquity of the innate system.

Cells and organs of the immune system: Hematopoiesis, primary and secondary lymphoid organs.

Complement: components of the system, activation, regulation, biological consequences and deficiency diseases. Inflammation and anti-inflammatory agents.

Antigens and antibodies: properties of immunogens, haptens, epitopes, structure and classes of immunoglobulins, biological activities and effector functions, monoclonal antibodies and abzymes.

Antibody diversity: models, organization of Ig genes, mechanism of gene rearrangement, generation of diversity; expression, synthesis and class switching, antibody engineering.

Production of polyclonal and monoclonal antibodies: Principles, Techniques and applications

Antigen-antibody interactions: Agglutination and precipitation techniques, Radio Immunoassay, ELISA, Immunofluorescence assays: Fluorescence activated cell sorter (FACS) technique, Cytotoxicity assay, Cytokines assays: ELISA and ELISPOT

Major histocompatibility complex and antigen presentation: MHC- organization, inheritance, genes, molecules and peptide binding, expression, disease susceptibility, immune responsiveness, self MHC restriction, cytosolic and endocytic pathway for antigen processing.

T-cell receptor, T-cell maturation, activation and differentiation: TCR- genetic organization and rearrangement of genes, TCR-complex, peptide binding, thymic selection, activation and differentiation of T cells.

Generation, activation and differentiation of B cells: B cell maturation, activation and proliferation, germinal centers, regulation of the responses.

Cell mediated cytotoxicity: effector T cells, cytotoxic T cells, NK cells, ADCC.

Hypersensitivity reactions: classification and types of hypersensitivity reactions.

Immune tolerance and autoimmunity: establishment and failure of tolerance, autoimmune diseases, mechanisms for the induction, animal models, treatment.

Transplantation immunology: basis and manifestation of graft rejection, immunosuppressive therapy, immune tolerance.

Experimental systems in immunology.

Reference books:

Kuby-Immunology: T. J. Kindt, R. A. Goldsby and B. A. Osborne; W. H. Freeman

Janeway's Immunology: K. Murphy, P. Travers and M. Walport; Garland Sciences

Immunology: Ivan Roitt, J. Brostoff and D. Male; Mosby

Essential immunology: Ivan Roitt; Oxford: Blackwell

Topic related review articles.

PS03CIBT03:Enzymology

- Structure and functions of enzymes: Properties of Amino Acids; Basis of protein structure; Chemical & acid-base properties of proteins ; Specificity of enzyme action; monomeric and oligomeric enzymes ; Co enzymes and Cofactors; Units of activity, Specific activity of enzyme and methods of enzyme assay.
- Protein sequencing;Enzymes Purification: methods and strategies for small and large scale purification
- Enzyme kinetics: Uni-substrate enzyme kinetics and factors affecting the rate of enzyme catalyzed reactions ; Forms and derivation of M.M. equation, significance of V max and Km.
- Enzyme inhibition – Type of inhibition, competitive, non competitive and uncompetitive kinetics
- Two substrate system kinetics-sequential and ping pong.
- Enzyme catalytic efficiency – factors associated with catalytic efficiency such as proximity, orientation-distortion or strain, and base nucleophilic catalysis with example.
- Detailed mechanism of catalysis of chymotrypsin, Lactate dehydrogenase and Triose phosphate isomerase
- Protein ligand binding, cooperative Hill and satchard plots..
- Allosteric enzymes, sigmoidal kinetics and their physiological significance, symmetric and sequential modes for action of allosteric enzymes and their significance.
- General mechanism of enzyme regulation, Reversible and irreversible covalent modification of enzymes. Feed Back inhibition and Feed Forward stimulation; Enzyme repression, induction and degradation, control of enzymatic activity by products and substrates; Enzyme engineering and its applications.

Reference Books:

- Fundamentals of Enzymology: Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.
- Enzyme Structure and mechanism: Alan Fersht, Reading, USA.
- Understanding Enzymes: Trevor Palmer
- The chemical kinetics of enzyme action: K. J. Laidler and P. S. Bunting, Oxford University Press, London.
- Enzymes: M. Dixon, E. C. Webb, CJR Thorne and K. F. Tipton, Longmans, London.

Elective

PS03EIBT01:HUMAN PHYSIOLOGY

- Blood-composition and functions of plasma, erythrocytes including Hb, leucocytes and thrombocytes and plasma proteins. Hemoglobinopathies, thalassemias and anemias. Blood clotting – extrinsic and intrinsic pathways of blood clotting, laboratory test to measure coagulation and thrombolysis.
- Digestive system – Composition, functions and regulation of saliva, gastric, pancreatic intestinal and bile secretions – digestion and absorption of carbohydrates, lipids, proteins nucleic acids, minerals and vitamins.
- Excretory system – structure of nephron formulation of urine, glomerular filtration, GFR, tubular reabsorption of glucose.
- The Muscular System – Types of muscles and their functions
- Nervous System- Structure of neuron, function and organization of nervous system, Nerve impulse transmission.
- Endocrine glands – secretion and function Reproduction, pregnancy and lactation. Hormonal

disturbances.

Reference Books:

- Molecular Biology of the cells: Alberts et. al., Garland Publications Inc. NY
- Cell and Molecular Biology by E D P de Robertis and E M F de Robertis.
- Text book of Medical Physiology by A. C. Guyton and J. E. Harcourt.
- Text book of Medical Physiology by Garong.
- Text book of Biochemistry and Human Biology by Talwar.
- Principles of anatomy and physiology by Tortora Grabowski, 10th edition

PS03CIBT04: Practicals of PS03CIBT01 and PS03CIBT02

PS03CIBT05: Practicals of PS03CIBT03 and PS03EIBT01

PS03CIBT06: Viva voce

IV SEMESTER

PS04CIBT01: Animal & Plant Biotechnology

Animal Biotechnology

- **Structure and organization of animal cells, tissues and biology of cultured cells.**
General out-line of epithelial tissue, connective tissue, muscular tissue and nerve tissue. Cell adhesion; Junctions; Extracellular matrix; Cytoskeleton; Cell cycle; Differentiation; Cell signalling; Energy metabolism
- **Introduction to the balanced salt solutions and growth medium:**
Media –Physical properties, balance salt solutions, complete media, serum, Serum-Free media, Chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Serum and protein free media and their application.
- **Primary and established cell line culture.** Measurement of viability and cytotoxicity. Biology, Characterization and growth of the cultured cells; Disaggregation of tissue and primary culture; Maintenance of cell culture; Cell cloning and cell separation; Cell differentiation; Cell synchronization and transformation; Measurement of cell death and apoptosis.
- **Embryonic stem cells, stem cell culture and their applications.**
Embryo technology and transgenic animals

Plant Biotechnology

Cell & tissue culture in plants; callus cultures; *in-vitro* morphogenesis-organogenesis and embryogenesis; Artificial Seeds, Micropropagation (Clonal propagation); Haploidy; anther and ovule cultures, Embryo cultures; Protoplast isolation, culture and protoplast fusion and somatic hybridization, Cybrids,

Somaclonal Variation; *in-vitro* mutation methods; Virus elimination, pathogen indexing; Cryopreservation; Production of secondary metabolites; Sources of plant secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; and biotransformation;

Principles and methods of genetic engineering, and its applications in Agriculture. Methods for genetic transformation and transgenic plants production through *Agrobacterim tumefaciens* and *A. rhiozogenes*; Gene transfer methods in plants; PEG-mediated, microinjection, particle bombardment, electroporation, Molecular markers and their importance in plant breeding. Biotechnology and intellectual property rights (IPR); Plant genetic resources GATT & TRIPS; Patent for higher plant genes and DNA sequence

Reference Books:

- Freshney, R. I: Culture of Animal Cells. Wiley-Liss.
- Masters, J. R. W. (ed.): Animal Cell Culture – Practical Approach, Oxford Univ. Press.
- Basega, R. (ed): Cell Growth and Division: A Practical Approach. IRL Press.
- Butler, M and Dawson, M. (eds.): Cell Culture Lab Fax, Eds., Bios Scientific Publications Ltd., Oxford.
- Clynes, M. (ed): Animal Cell Culture Techniques. Springer.
- Mather, J.P and Barnes, D. (eds). : Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Academic Press.
- Plant biotechnology – J Hammond, *et. al.*, Springer Verlag.
- Plant cell and tissue culture for production of food ingredients – T J Fu, G Singh, *et. al.*
- Biotechnology in crop improvement – H S Chawla.
- Practical application of plant molecular biology – R J Henry, Chapman & Hall.
- Elements of biotechnology – P K Gupta.
- An introduction to plant tissue culture – M K Razdan.
- Plant propagation by tissue culture : The technology (Vols. 1 & 2) – Edwin George.
- Handbook of plant cell culture (Vols. 1 to 4) – Evans *et. al.*, Macmillan.
- Plant tissue and cell culture – H E Street, Blackwell Scientific.
- Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
- Plant cell culture technology – M M Yeoman.
- Plant tissue culture and its biotechnological applications – W Bary, *et. al.*, Springer Verlag.
- Principles of plant biotechnology : An introduction to genetic engineering in plants – S H Mantel, *et. al.*
- Advances in biochemical engineering / Biotechnology – Anderson, *et. al.*
- Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert & Bajaj Y P S, Springer Verlag.
- Plant cell and tissue culture – S Narayanswamy, Tata Mc Graw Hill Co.

PS04CIBT02: Environmental Biotechnology

- Issues and scopes of environmental biotechnology.
- Waste water treatment- Waste water characterization and its significance: COD, BOD, Inorganic constituents, solids, biological components. Primary, secondary and tertiary treatment of waste water. Principles and aims of biological wastewater treatment processes. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal. Suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds. Fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed and submerged aerated filters.
- Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion. Anaerobic waste water treatment systems: RBC, UASB, anaerobic filters. Merits and demerits of anaerobic treatment of waste.
- Toxicity testing in waste water treatment plants using microorganisms.
- Composting: Objectives, fundamentals, microbiology, factors influencing composting and

composting systems. Compost quality and uses. Vermicomposting.

- Biodegradation of organic pollutants: Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides.
- Bioremediation: Intrinsic bioremediation, Biostimulation and Bioaugmentation. *In situ* and *ex situ* bioremediation technologies. Bioremediation of oil spills. Bioremediation of heavy metal pollution, Phytoremediation. Use of GMO in bioremediation. Biological treatment of waste gas (polluted air): biofilters, bioscrubbers, membrane bioreactors, biotrickling filters.
- Biogeotechnology- Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes. Biobeneficiation of gold ores. Microbially enhanced oil recovery. Biodesulfurization of coal: Removal of organic and inorganic sulfur from coal.
- Microbial Insecticides: Bacterial, fungal and viral insecticides in pest management.
- Biofertilizers: Nitrogen fixing and phosphate solubilizing biofertilizers.

Reference Books:

- Comprehensive Biotechnology Vol-4, Murray Moo Young.
- Biotechnology-Rehm and Reid.
- Waste water microbiology by G. Bitton
- Biodegradation and bioremediation by M.Alexander
- Waste water treatment for pollution control, 2nd edition. Arceivala
- Environmental Biotechnology by H. Jordening and Josef Winter
- Topic related review articles

PS04CIBT03: Practicals of PS04CIBT01and PS04CIBT02

PS04CIBT04: Dissertation

PS04CIBT05: Viva voce