JIWAJI UNIVERSITY, GWALIOR

(NAAC "A" GRADE)

M.Sc. BIOTECHNOLOGY

SYLLABUS

2020-2022

JIWAJI UNIVERSITY, GWALIOR-474011
M.SC. BIOTECHNOLOGY

CURRICULUM - 2020-2022

Semester	Course Code	Title of the Paper	Type	Credits
First	BT-101	Cell Biology	Core	03
	BT-102	Microbiology	Core	03
	BT-103	Biomolecules and Metabolism	Core	03
	BT-104	Bioinstrumentation	Core	03
	BT-105	Practical-I	Core	03
	BT-106	Practical-II	Core	03
	BT-107	Seminar	Core	01
	BT-108	Assignment	Core	01
	BT-109	Comprehensive Viva Voce	Virtual	04
			Total Credits	**24**
Second	BT-201	Molecular Biology	Core	03
	BT-202	Immuno-technology	Core	03
	BT-203	Environmental & Animal Biotechnology	Core	03
	BT-204	Enzyme-technology	Core	03
	BT-205	Practical-I	Core	03
	BT-206	Practical-II	Core	03
	BT-207	Seminar	Core	01
	BT-208	Assignment	Core	01
	BT-209	Comprehensive Viva-Voce	Virtual	04
			Total Credits	**24**
Third	BT-301	Bioprocess Engineering & Microbial technology	Core	03
	BT-302	Genetic Engineering	Core	03
	BT-303A BT-303B	Biostatistics and Bioinformatics Entrepreneurship in Biotechnology	Centric Elective	03
	BT-304A BT-304B	Plant Biotechnology Nano-Biotechnology	Generic Elective	03
	BT-305	Practical-I	Core	03
	BT-306	Practical-II	Generic	03
	BT-307	Seminar	Core	01
	BT-308	Assignment	Core	01
	BT-309	Comprehensive Viva Voce	Virtual	04
			Total Credits	**24**
Fourth	BT-401	Emerging Trends in Biotechnology	Core	03
	BT-402	Project Work	Core	15
	BT-403	Seminar	Core	01
	BT-404	Assignment	Core	01
	BT-405	Comprehensive Viva Voce	Virtual	04
			Total Credits	**24**

-Minimum Number of credits be earned for award of degree- 96 credits

[Valid credits 80 + Virtual credits 16]

There are weekly seminars and continuous internal assessment throughout the course

BT-101: CELL BIOLOGY

UNIT I

1. Cell Membrane: physicochemical properties and asymmetrical organization of lipids and proteins
2. Transport of small molecules across cell membranes: types and mechanism
3. Active Transport by ATP-powered pumps types:p-type, V-type, F-type ABC transporters
4. Properties and mechanisms of transporters

UNIT II

1. Protein targeting-cell map: signal hypothesis and default protein secretory pathway
2. Protein targeting: endoplasmic reticulum, golgi body, lysosome and mitochondria
3. Protein glycosylation-N and O linkages
4. Transport by vesicle formation: endocytosis and exocytosis

UNIT III

1. Ultra structure and function of lysosomes
2. Ultra structure and function of peroxisomes
3. Cell motility: structure and functions of microfilaments and microtubules and intermediate filaments
4. Cell junctions: occluding junctions, anchoring junctions and communicating junctions

UNIT IV

1. Molecular mechanism of Ca^{++} dependent cell adhesion
2. Molecular mechanism of Ca^{++} independent cell adhesion
3. Organization and functionsofextra-cellular matrix in animals
4. Extra-cellular matrix receptors on animal cells: integrins

UNIT V

1. Cell Signaling: G-Protein signaling, initiation and regulation of MAP kinase pathway
2. Molecular events accompanying eukaryotic cell cycle: miotosis
3. The cell cycle control proteins: cyclins
4. Apoptosis: pathway and significance

Practical Exercises

1. Sub cellular fractionation
2. Chromosome preparation: Mitosis – Onion root tip, rat/mouse cornea, rat/mouse bone marrow, human lymphocytes
3. Chromosome preparation: Meiosis – Rat/mouse testis, Grasshopper testis
4. Polytene chromosome preparation from Drosophila salivary gland
5. Identification of tissue typing: Histological preparation of tissue
6. Identification of different biomolecules in different tissues by histochemical techniques
7. Electron microscopy: Demonstration and good photographs for interpretation

Reference Books

1. Molecular Biology of the Cell (2002), Alberts et al
2. Molecular Cell Biology (2004), Lodish et al
3. Working with Molecular Cell Biology: A study Companion (2000), Storrie et al
4. Cell and Molecular Biology: Concepts and Experiments (3rd Ed., 2002), Gerald Karp
5. The Cell: A Molecular Approach (2004), G.M. Cooper
6. The Word of the Cell (1996), Becker et al
7. Cell Proliferation and Apoptosis (2003), Hughes and Mehnet
8. Essential Cell Biology (1998), Alberts et al
9. Biochemistry and Molecular Biology of Plants (2000), Buchanan et al
10. Harpers Biochemistry Murray et al

BT-102: MICROBIOLOGY

UNIT I

1. Classification of Microorganisms
2. Morphology and structure of cell wall; eubacteria, archaea bacteria and fungi
3. Microbial culture media: types and applications pure culture techniques and microbial staining
4. General account and economic importance of cyanobacteria

UNIT II

1. Sterilization: physical and chemical methods
2. Microbial growth: growth curve, measurement of growth and factors affecting growth
3. Nutrition based classification of microorganisms, different carbon and nitrogen sources, transport of nutrition across membrane
4. Oxygen toxicity: study of catalase, peroxidase, superoxidase dismutase, mechanism of oxygen toxicity

UNIT III

1. Infection and disease, types of infection, mechanism of pathogenesis of bacterial and viral diseases
2. *Staphylococcal* and *Clostridia* food poisoning, Bacterial diseases: *Salmonellosis* and *Shigellosis*
3. Fungal Diseases: *Aspergillosis* and *Candidasis*
4. Viral diseases: Hepatitis B and HIV

UNIT IV

1. Viruses: types, isolation, cultivation and identification
2. Lytic and lysogenic cycle of bacteriophages
3. Life cycle of DNA viruses: SV 40, RNA viruses: Retroviruses
4. Plant viruses: TMV and Gemini

UNIT V

1. Bacterial Recombination: transformation, conjugation, transduction, F-duction
2. Chemotherapeutic agents: classification of antibiotics, broad and narrow spectrum antibiotics
3. Anti-fungal and antiviral antibiotics, mode of action of antibiotics
4. Mechanism of drug resistance

Practical Exercises

1. Preparation of Liquid and Solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution method, slant and stab cultures, storage of microorganisms.
3. Isolation of pure cultures from soil and water
4. Growth; Growth curve; Measurement of bacteria population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria, Yeast and mold and study of organism by Gram's stain, acid fast stain and staining for spores
6. Study of mutation by Ame's Test.
7. Assay of antibiotics and demonstration of antibiotic resistance
8. Analysis of water for potability and determination of MPN.
9. Bacterial transformation.
10. Biochemical Characterization of selected microbes.
11. One Step growth curve of coliphage.

Reference Books

1. General microbiology, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan Press Ltd.
2. Brock Biology of microorganism, M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelczar, M.J., Chan E.C.S. and Kreig, N.R., Tata McGraw Hill.
4. Microbial Genetics, Malloy, S.R., Cronan, J.E. Jr and Freifelder, D.Jones, Bartlett Publishers
5. Microbiology-A Laboratory Manual, cappuccino, J.G. Sherman, N. Addison Wesley.
6. Microbiological Applications (A Laboratory Manual in General microbiology) Benson, H.J. WCB: Wm C Brown Publishers

BT-103: BIOMOLECULES & METABOLISM

UNIT I

1. Carbohydrates: structure, classification, properties and functions
2. Homo and hetero polysaccharides: carbohydrate derivatives
3. Lipids classification, structure, properties and functions
4. Lipids with specific biological functions: micelles and liposomes

UNIT II

1. Amino acids: structure, classification, properties and functions, peptides and polypeptides
2. Proteins: properties, primary, secondary, tertiary and quaternary structure
3. Water soluble vitamins; structure, distribution, interaction and functions
4. Fat soluble vitamins: structure, distribution and functions

UNIT III

1. Nucleotides: structure of purines and pyrimidine bases, nucleosides and nucleotides
2. DNA: structure and confirmation
3. DNA: denaturation, degradation and modification
4. RNA: structure, types and functions of mRNA, tRNA and rRNA

UNIT IV

1. First and second laws of thermodynamics & concept of free energy
2. ATP synthesis and its importance in biological reactions
3. Carbohydrate metabolism: basic concepts of glycolysis, Krebs cycle, glycogenesis, pentose phosphate pathway and gluconeogenesis
4. Electron transport and oxidative phosphorylation : electron carriers, complexes I to IV, chemiosmotic theory

UNIT V

1. Overview of amino acid metabolism
2. Regulation of amino acid metabolism
3. Overview of nucleotide metabolism
4. Inborn errors of metabolism

Practical Exercises

1. Titration of amino acids.
2. Colorometric determination of pK.
3. Model building using space filling/ ball and stick models.
4. Reactions of amino acids, sugars and lipids.
5. Quantitation of proteins and sugars.
6. Analysis of oils- iodine number, saponification value, acid number.

Reference Books

1. Principles of Biochemistry by Nelson, Cox and Lehninger.
2. Biochemistry by G. Zubay
3. Biochemistry by Stryer
4. Biochemistry by Garrett and Grisham
5. Biochemical Calculations, Irwin H. Segel, john Wiley and sons Inc
6. Biochemistry,DVoet and jGVoet , J Wiley and Sons
7. Biochemistry, D Freifilder, W.H. Freeman & Company
8. Laboratory Techniques in Biochemistry and molecular Biology, Work and Work
9. A Biologists guide to Principles and Techniques of practical Biochemistry, K.Wilson& K.H. Goulding, ELBS Edition

BT-104: BIOINSTRUMENTATION

UNIT I

1. Centrifugation: basic principles, types and applications
2. Photometry: basic principles, instrumentation and application of UV-visible spectrophotometry
3. Infrared (IR) spectroscopy and its applications
4. Fluorescence spectroscopy: principle, instrumentation and applications

UNIT II

1. Chromatography: principle and applications; HPLC
2. Column chromatography: gel filtration, ion exchange and affinity chromatography
3. Electrophoresis: principle, types (AGE, Native & SDS PAGE) and applications
4. 2-D gel electrophoresis and its applications

UNIT III

1. Electron spin resonance (ESR) spectroscopy
2. Nuclear magnetic resonance (NMR)
3. Atomic absorption spectroscopy: principle, instrumentation and application
4. X-ray crystallography

UNIT IV

1. Mass spectrometry: principle and components of mass spectrometer
2. Mass analyzers: magnetic sector, time of flight (TOF), Quadruple
3. Cell Sorting: principle and applications
4. Flow cytometry: principle and applications

UNIT V

1. Microtomy and sample preparation for microscopy
2. Microscopy: basic principle and components of microscope
3. Phase contrast and fluorescent microscopes
4. Electron microscopy: principle and applications

Practical Exercises

1. Verification of Beer's law
2. Determination of absorption maxima
3. Electrophoresis of Proteins- native and under denaturing conditions.
4. Amino acid and carbohydrate separations by paper & thin layer chromatography
5. Gas chromatography
6. Ion exchange and gel filtration chromatography
7. Separation of subcellular organelles by differential centrifugation
8. Separation of blood cells by density gradient centrifugation

Reference Books

1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freifelder
2. Biochemical Techniques : Theory and Practice by Robyt and White
3. Principles of Instrumental Analysis by Skoog and West
4. Analytical Biochemistry by Holme and Peck
5. Biological Spectroscopy by Campbell and Dwek
6. Organic Spectroscopy by Kemp
7. A Biologist's Guide to Pronciples and Techniques of Practical Biochemistry by Wilson and Goulding
8. Principles of Instrumental Analysis by Skoog, Hollar and Nicman

BT-105 Practical –I

Consist of practical exercises listed out under BT-101 and BT-102

BT-106 Practical –II

Consist of practical exercises listed out under BT-103 and BT-104

BT-107 Seminar

BT-108 Assignment

BT-109 Comprehensive viva-voce

BT-201: MOLECULAR BIOLOGY

UNIT I

1. Nature of Gene: chemical nature of gene, split genes, overlapping genes, nested genes and pseudo genes
2. DNA Replication: General features of chromosomal replication. DNA replication machinery in prokaryotes and its comparisons with eukaryotes
3. Enzymology of DNA Replication: types and role
4. DNA damage and repair mechanisms

UNIT II

1. Transcription in prokaryotes: structure and function of prokaryotic promoters
2. Structure and function of RNA polymerase: Sigma factors- types and functions
3. Control of transcriptional termination: attenuation and anti-termination
4. Operon concept: structure and regulation of lactose and tryptophan operons

UNIT III

1. Initiation of transcription in eukaryotes: RNA polymerases types and properties
2. Transcription factors- types and properties: Enhancers- structure and properties
3. Post- transcriptional modifications in eukaryotes
4. Splicing and RNA editing

UNIT IV

1. Genetic code: Wobble hypothesis
2. Translation: stages of protein synthesis in prokaryotes and eukaryotes
3. Post-translational modification: types and significance
4. Translational proof reading

UNIT V

1. Regulation of gene expression in eukaryotes: *cis and trans*-acting elements
2. Chromatin organization and regulation of gene expression
3. Transposable elements in prokaryotes and eukaryotes
4. Oncogenes and tumor suppressor genes

Practical Exercises

1. Isolation of Genomic DNA and restriction Digestion
2. Size fractionation of restricted DNA fragments by Agarose Gel Electrophoresis
3. Quantitation of DNA
4. Determination of Amax of purified DNA fragments
5. Determination of Tm of nucleic acid
6. Isolation of RNA
7. Fractionation of poly (A) RNA
8. *In vitro* transcription
9. *In vitro* translation
10. Metabolic labeling of proteins and immunoprecipitation
11. Protein-DNA interaction

Reference Books

1. Genes IX Benjamin Lewin
2. Molecular Biology , turner et al
3. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp
4. Translational regulation in eukaryotes (2000), Carey and Smale
5. Translational control of Gene Expression (2000), Sonenberg et al
6. Chromatin and Gene Regulation (2001), Turner
7. An Introduction to Genetic Analysis, Griffiths et al
8. Genome (1999), Brown
9. Concepts pf Genetics, Klug and Cummings
10. Proteins, Creighton
11. Molecular Cell Biology, Lodish et al
12. Biochemistry and Molecular Biology of Plants (2000), Buchanan
13. Plant Biochemistry and Molecular Biology, Lea and Leegood
14. Plant Biochemistry (1997), Dey and Harborne

BT-202: IMMUNO-TECHNOLOGY

UNIT I

1. Immune response: Innate and adaptive immune system, Hematopoiesis and differentiation of hematopoietic cells by cytokines
2. Anatomical organization of immune system: Primary and secondary lymphoid organs
3. Cell of immune system: mononuclear cells and granulocyte, antigen presenting cells; Lymphocytes and their subsets
4. Inflammation: its mediators and the process, immune response leading to an inflammatory reaction

UNIT II

1. Major histocompatibility systems: Organization of MHC with complex in humans
2. Antigen processing; role of MHC molecules in antigen presentation and co stimulatory signals
3. T-cell receptor complex, T-cell accessory membrane molecules, activation of T-cell, organization and arrangement of T-cell receptor genes
4. B-cell receptor complex, Immunoglobulin's (class and subclass): structures type and function. Antigenic determinants of immunoglobulins (isotype, allotype and idiotype)

UNIT III

1. Molecular mechanism of antibody diversity; class switching
2. Antigen-Antibody infestation and affinity amusement
3. Monoclonal Antibodies: Principle of hybridoma technology and its application
4. Complement system: components, activation pathway; opsonization (opsonin)

UNIT IV

1. Cytokines: Structure and function, cytokine related diseases and therapeutic application of cytokines
2. Cytotoxic T-Cell and their mechanism of action, NK cell and mechanism of target cell destruction, antibody dependent cell mediated cytotoxicity
3. Immuno-regulation by antigens, antibodies and immune complexes
4. Hypersensitivity: types and related diseases

UNIT V

1. Mechanism of autoimmunity
2. Immunodeficiency syndromes; viral (HIV): diagnosis and therapeutic approaches
3. Vaccines: active and passive immunization; recombinant-vector vaccines, DNA vaccines, synthetic peptide vaccines and sub-unit vaccines
4. Techniques in cellular immunology; precipitation and agglutination techniques, ELISA, western blotting and immuno-histochemical techniques

Practical Exercises

1. Blood Film Preparation and identification of cells.
2. Lymphoid organs and their microscopic organization.
3. Immunization and production of polyclonal antibodies.
4. Double diffusion and Immuno-electrophoresis.
5. Radial immunodiffusion.
6. Purification of IgG from serum.
7. Separation of mononuclear cell by Ficoll-paque.
8. Con-A induced proliferation of thymocytes (by MTT Method).
9. Western blotting.
10. ELISA
11. Preparation o antibody-enzyme conjugates.

Reference Books

1. Immunology, Kubey, R.A. Goldsby, Thomas J.Kindt, Barbara, A. Osbarne (Freeman).
2. Immunology- A short Course, Eli Benamini, Richard Coico, Geoffrey Sunshine.
3. Immunology by Tizzard
4. Fundamentals of Immunology, William Paul.
5. Immunology by Roitt and others.
6. Immunology by Abbas

BT-203: ENVIORNMENTAL BIOTECHNOLOGY (Part A)

UNIT I

1. Environment pollution: types, methods for measurement of pollution
2. Solid waste treatment: composting process, vermi-composting and its advantages
3. Biomedical waste and its management
4. Xenobiotics and its degradation

UNIT II

1. Microbial waste treatments: aerobic and anaerobic processes
2. An integrated pest management- biopesticides: types and impact on environment
3. Bioremediation: *In situ* and *Ex situ* techniques advantages and applications of genetically engineered microbes (GEM) in bioremediation
4. Phytoremediation: types and applications, Bio-indicators, GMOs and assessment of environmental impact and monitoring

Practical Exercises

1. Determination of dissolved oxygen concentration of water sample
2. Determination of biological oxygen demand (BOD) of sewage sample
3. Determination of Chemical oxygen demand (COD) of sewage sample
4. Isolation of xenobiot ic degrading bacteria by selective enrichment technique
5. Test for the degradation of aromatic hydrocarbons by bacteria
6. Survey of degradative plasmids in microbes growing in polluted environment
7. Study on biogenic methane production in different habitats

Reference Books

1. Comprehensive Biotechnology. Vol. 4,M. moo- young (Ed-in-chief), Pergmon Press Oxford
2. Environmental chemistry. A.K. De, Wiley Eastern Ltd., New Delhi
3. Introduction to Biodeterioration. D.Allsopp and Seal, ELBS/ Edward Arnold
4. Environmental Biotechnologies and Cleaner Bioprocess by Eugenia J Olguuin et al
5. Environmental Science: Physical Principles and applications by Egbert Boeker et al

BT-203: ANIMAL BIOTECHNOLOGY (Part B)

UNIT III

1. Animal cell culture: organization of animal cell and tissue culture laboratory
2. Culture medium: types, functions of different constituents of media, role of Co_2
3. Cell lines; primary and established cell lines, cryopreservation
4. Measurement of growth parameters

UNIT IV

1. Scaling up of animal cell culture; cell synchronization
2. Cell cloning and selection of animal cells
3. Measurement of cell viability; methods of cell separation
4. Stem cell cultures, embryonic stem cells and their applications

UNIT V

1. Cytotoxicity assay: types and their significance
2. Cell culture based vaccines
3. 3-D animal cell culture
4. Applications of animal cell culture

Practical Exercises

1. Preparation of tissue culture medium and membrane filtration
2. Preparation of single cell suspension from spleen and thymus
3. Cell counting and viability
4. Macrophage monolayer from PEC and measurement of phagocytic activity
5. Cell fusion with PEG

Reference Books

1. Culture of Animal Cells by RI Freshney
2. Animal Cell Culture: Practical Approach John R W Masters
3. Animal Cell Culture Techniques by Ed. Martin Clynes
4. Methods in Cell Biology Vol. 57, Animal cell culture methods

BT-204: ENZYME-TECHNOLOGY

UNIT I

1. Enzyme: Historical aspects, classification and nomenclature, EC number
2. Mechanism of enzyme catalysis and properties of enzymes as catalyst
3. Lock & key hypothesis and induced fit hypothesis
4. Methods of enzyme assay: continuous and sampling techniques, coupled enzyme assays, specific activity and turn over number

UNIT II

1. Enzyme purification: objectives and strategy, methods of isolation and affinity purification
2. Criteria of purity and tabulation of purification data, stable storage of enzymes
3. Characterization of purified enzyme
4. Active site mapping and its applications

UNIT III

1. Enzyme kinetics: Equilibrium and steady state theory, rate equation and determination of Km and V_{max}
2. Factors affecting rate of enzyme reaction: pH, temperature and pressure
3. Enzyme inhibition: reversible and irreversible inhibition, applications of inhibitors
4. Rapid reaction techniques

UNIT IV

1. Isoenzymes and their physiological significance
2. Allosteric enzymes: co-operativity, MWC and KNF models
3. Regulation of enzymes
4. Ribozymes and its applications

UNIT V

1. Enzyme Immobilization: methods and its effect on kinetic parameters
2. Industrial applications of immobilized enzymes
3. Enzyme biosensor: principle, types and components of biosensor
4. Applications of biosensor for clinical diagnosis

Practical Exercises

1. Urease estimation by tritiometric method
2. Urease estimation by colorimetric method
3. Acid phosphatase estimation
4. Alkaline phosphatase estimation
5. Determination of optimum time, optimum temperature & optimum pH
6. Determination of Km value
7. Acetylcholine esterase/pseudocholinesterase estimation
8. Enzyme purification

Reference Books

1. The nature of Enzymology by R.L. Foster
2. Enzymes by Dixon and Webb
3. Fundamentals of Enzymology by Price and Stevens
4. Enzyme Catalysis and Regulation by Hammes
5. Enzyme Reaction Mechanisms by Walsch
6. The Enzymes vol I and II by Boyer
7. Enzyme Structure and Mechanism by Alan Fersht
8. Enzyme Assays : A Practical Approach by Eisenthal and Danson

BT-205 Practical –I

Consist of practical exercises listed out under BT-201 and BT-202

BT-206 Practical –II

Consist of practical exercises listed out under BT-203 and BT-204

BT-207 Seminar

BT-208 Assignment

BT-209 Comprehensive viva-voce

BT-301: BIOPROCESS ENGINEERING AND MICROBIAL TECHNOLOGY

UNIT I

1. Introduction and basic principle of biochemical engineering
2. Isolation, preservation and maintenance of industrially important microbes: Strain improvement of industrially important microorganisms
3. Kinetics of microbial growth and death
4. Media for industrial fermentation, media formulation; Sterilization; Aeration and agitation in bioprocess

UNIT II

1. Scale of fermentation process: small scale, large scale and pilot scale fermentations
2. Biorecators: Principle, types, design and applications
3. Types of fermentation processes; batch, fed-batch, and continuous bioreactions
4. Measurement and control of fermentation: pH, temperature, pressure, media, air, automation of the monitoring and control process

UNIT III

1. Upstream processing and downstream processing: Introduction and concept
2. Downstream processing: removal of microbial cells and solid matter, foam separation, precipitation, centrifugation, cell disruption, reverse osmosis
3. Extraction: Solvent, two phases, liquid extraction
4. Product recovery process. Crystallization, storage, packaging and quality control

UNIT IV

1. Industrial production: Vitamins and amino acids (Vit B_{12} & glutamic acid)
2. Industrial production: antibiotics: Penicillin and streptomycin
3. Enzyme production: Amylase and Protease
4. Recovery and scaling up of enzymes and their applications

UNIT V

1. Microbial production of alcoholic beverages: distilled alcoholic beverages-beer, microbial production of vinegar
2. Microbial production of organic acids: citric acid and acetic acid
3. Microbial production of solvents: ethanol and acetone
4. Microbial production of food: SCP and their applications

Practical Exercises

1. Isolation of industrially important microbes from the environment
2. Determination of TDP and TDT of microorganisms for a design of a sterilizer
3. Determination of growth curve of a industrial organism and compute substrate, degradation profile, specific growth rate and growth yield
4. Screening and enrichment for a primary/ secondary metabolite from the environment
5. Strain improvement for higher yield of a product
6. Random and strategic screening for a metabolite
7. Media balancing experiments
8. Alcohol fermentation using different substrates and its downstream processing

Reference Books

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and millis, N.F. Univ. Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B., Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily. J. E. and ollis , D.F. Mcgraw- Hill Book Co. New York.
4. Bioprocess Technology: Fundamentals and Applications , KTH, Stockhlom.
5. Process Engineering in Biotechnology, Jackson, A.T. , Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts Shuler, M.L. and Kargi , F., Prentice Hall, Englewood Cliffs..
7. Principles of fermentation Technology, Stanbury,P.F. and Whitakar A., Pergmon Press, Oxford.
8. Bioreaction Engineering Principles, Nielson, J and Villadsen , J., Plenum Press.
9. Chemical Engineering, Problems in Biotechnology, Shuler, M.L.(Ed.), AICHE.
10. Biochemical Engineering, Lee, J.M., Prentice Hall Inc.
11. Bioprocess Engineering- Kinetics, Mass Transport, Reactiors and Gene Expression, Vieth, W.F., John Wiley & Sons, Inc.

BT-302: GENETIC ENGINEERING

UNIT I

1. Concept and Principle of recombinant DNA Technology
2. Restriction endonucleases: properties and types
3. Prokaryotic host-vector system : Characteristics of *E. coli* as host; vectors for cloning in *E. coli* (plasmid, bacteriophage and cosmid), Shuttle vectors
4. Genome editing: principle and applications

UNIT II

1. Design and characteristics of expression vectors for cloning in prokaryotes
2. Cloning in yeast: YACs
3. Methods of introduction of foreign DNA into animal system
4. Viral vectors: SV-40, vaccinia virus and retrovirus vectors

UNIT III

1. Methods for screening and selection of recombinant clones
2. Methods for constructing rDNA
3. DNA Libraries: types, advantages and disadvantages
4. Restriction mapping of the insert

UNIT IV

1. DNA sequencing: chemical and enzymatic methods, high throughputs sequencers
2. Localization of cloned segments in genomes: molecular and chromosomal location
3. Methods for determination of copy number of a cloned gene in genome
4. Mutant construction: deletion, insertion and point mutation

UNIT V

1. Gene silencing: principle and applications
2. Polymerase chain reaction and types (multiplex, nested, real time, touchdown PCR, hot start PCR, colony PCR)
3. Cloning of animals; methods and applications
4. Applications of recombinant DNA technology in medicine and agriculture

Practical Exercises

1. Bacterial Culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA
3. Isolation of phage DNA
4. Quantitation of nucleic acids
5. Restriction mapping of plasmid DNA
6. Cloning in plasmid/phagemid vectors
7. Preparation of helper phage and its titration
8. Preparation of single stranded DNA template
9. Gene expression in *E .coli* and analysis of gene product
10. Polymerase Chain Reaction

Reference Books

1. Recombinant DNA – By Watson et al
2. Principles of Gene Manipulation, Old and Primrose
3. Gene Cloning: An introduction , Brown
4. Biotechnology: Theory and Techniques (Vol I & II, 1995), Chirikjian
5. Molecular Genetics of Bacteria , Dale
6. Molecular Cloning (Vol I, II & III, 2001), Sambrook & Russell
7. Applied Molecular Genetics (1999), Miesfeld
8. Genes and Genome (1991), Singer & Berg
9. Molecular Biotechnology , Glick & Pasternak
10. Plant Molecular Biology (Vol I & II, 2002), Gilmartin & Bowler

BT-303-A: BIOSTATISTICS AND BIOINFORMATICS

UNIT I

1. Introduction to Biostatistics, population and Sampling Methods
2. Classification, tabulation and graphical presentation of data
3. Frequency Distribution, Measures and central values
4. Measures of variability, Standard deviation, Standard error, Coefficient of variation, Analysis of variance (ANOVA)

UNIT II

1. Test of Significance, t-test, chi-square test
2. Regression: regression analysis, estimation, testing, prediction, checking and residual analysis
3. Multivariate Analysis
4. Design of Experiment, randomization, replication, local control, randomized block design

Unit III

1. Bioinformatics: Application of bioinformatics in biotechnology
2. Biological databases: primary database, secondary database and composite database
3. Sequence databases: Nucleic acid (EMBL and GenBank), protein databases (PIR and SWISS-PROT)
4. Structure database: protein data bank (PDB)

Unit IV

1. Sequence analysis: biological motivation of sequence analysis, homology (orthologs, Paralogs)
2. Base Pair Alignment: local alignment, global alignment, tools for base pair alignment- BLAST and FASTA
3. Methods of Multiple sequence alignment (MSA)
4. Phylogenetic analysis: character based methods, distance based methods, tree evaluation

Unit V

1. Protein structure prediction: homology modelling, threading, ab-initio methods
2. Computer aided drug designing- basic principles, docking and types of docking
3. Expression Sequence Tags (EST) and its applications
4. Microarray database and its application

Reference Books

1. Introduction to Bioinformatics: A theoretical and practical approach by Stephen A Krawetz and DD Womble
2. Bioinformatics Genes, Proteins & Computers by CA Orengo, DT Jopnes and JM Thornton
3. An Introduction to Computational Biochemistry by C Stan T Sai
4. Instant notes on Bioinformatics by DR Westhead, JM Perish & RM Toyman
5. Essential Bioinformatics by Jin Xiong
6. An Introduction to Bioinformatics Algorithms by Neil C. Jones, Pavel Pevzner
7. Bioinformatics: Sequence and Genome Analysis by David W. Mount
8. Statistical Methods in Bioinformatics: An Introduction by Stephen Misener, Stephen A. Krawetz.
9. Bioinformatics: databases and Algorithms by N. Gautham
10. Bioinformatics Technologies by Yi-Ping Phoebe Chen
11. Data Mining: Multimedia, Soft Computing and Bioinformatics by Sushmita Mitra, Tinku Acharya

BT-303-B: ETERPRENEURSHIP IN BIOTECHNOLOGY

UNIT I

1. Creativity and Entrepreneurial personality and Entrepreneurship in Biotechnology
2. Organizational Structure and management
3. Capital management
4. Product innovation and management
5. Government schemes for commercialization of technology (Eg. Biotech Consortium).

UNIT II

1. Basics of production management: Methods of manufacturing-Project/ jobbing, Batch production, process production-Characteristics of each method. Plant location-Importance-Factors affecting location-Factory building-Plant layout- Installation of facilities.
2. Operational research: Linear programming, PERT and CPM; Production planning and Control-Scheduling-Gantt Charts-Documentation-Production-Work Order.
3. Basics of material management.

UNIT III

1. Kaizen (Continuous improvement in product and management)
2. Six Sigma
3. Biotech enterprises: Small, Medium and Large
4. Quality control in Biotech industries.

UNIT IV

1. Government regulations for Biotech products
2. Public policy, regulatory and ethical challenges facing the biotechnology entrepreneurship
3. Business development for medical products
4. Business development for consumable products.

UNIT V

1. Patenting System: WTO, Paris Convention, Indian Legislations.
2. Intellectual Property: A. Copy Right and Industrial Properties, Trade Marks, Designs, geographical Indications.
3. IPR and Technology Transfer, Role if patentee and Licensor
4. Patent process and Patent Laws and e-filing.

Reference Books

1. Innovation and Entrepreneurship in Biotechnology: Concept, Theories and Cases by Hyne & Others.
2. John Kapeleris, 2006.
3. The business of Biotechnology: From the bench to the Street: by Richard Dano Ono, published by Butterworth-Heinemann, 1991.
4. Entrepreneurship in Biotechnology: Managing For Growth from start-up: By Martin Gross Mann, 2003.
5. Best Practices inBiotechnology Education: By Yali Friedman, published by Logos Press, 2008.
6. Plant Development and Biotechnology: By Robert Nicholas Trigiano, Dennis John Gray; published by CRC Press, 2004.

BT-304-A: PLANT BIOTECHNOLOGY

UNIT I

1. Objectives and landmarks in plant breeding
2. Mutation breeding and distant hybridization
3. Genetically modified crops for resistance against biotic and abiotic stresses
4. Seed production techniques: release of new varieties

UNIT II

1. Introduction to plant tissue culture: Tissue Culture Media preparation
2. Initiation of callus culture and its maintenance
3. Cell synchronization
4. Organogenesis: Somatic embryo hybridization

UNIT III

1. Somaclonal variation and its application for plant improvement
2. Anther culture: plant production and their applications
3. Protoplast technology: isolation and fusion methods
4. Cryopreservation techniques and is application

UNIT IV

1. Plant cloning vectors: *Ti* & *Ri* plasmid
2. Transgenic crops for quality improvement
3. Insect resistance: Bt genes, Non-Bt like protease inhibitors and lectins
4. Marker types: morphological, biochemical and molecular; advantages and disadvantages, choice of mapping populations

UNIT V

1. Plant DNA fingerprinting: PCR based markers (RAPD, SSR's and SCAR)
2. Plant Genome mapping: Physical and molecular maps
3. Plant breeders' right: UPOV and germplasm maintenance
4. Intellectual property right (IPR) and patenting of biological material

Practical Exercises

1. Bacterial Culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA
3. Isolation of phage DNA
4. Quantitation of nucleic acids
5. Restriction mapping of plasmid DNA
6. Cloning in plasmid/phagemid vectors
7. Preparation of helper phage and its titration
8. Preparation of single stranded DNA template
9. Gene expression in *E .coli* and analysis of gene product
10. Polymerase Chain Reaction

Reference Books

1. Recombinant DNA – By Watson et al
2. Principles of Gene Manipulation, Old and Primrose
3. Gene Cloning: An introduction , Brown
4. Biotechnology: Theory and Techniques (Vol I & II, 1995), Chirikjian
5. Molecular Genetics of Bacteria , Dale
6. Molecular Cloning (Vol I, II & III, 2001), Sambrook & Russell
7. Applied Molecular Genetics (1999), Miesfeld
8. Genes and Genome (1991), Singer & Berg
9. Molecular Biotechnology , Glick & Pasternak
10. Plant Molecular Biology (Vol I & II, 2002), Gilmartin & Bowler

BT-304-B: Nano-Biotechnology

Unit I

1. Definitions and historical evolution of nanomaterial
2. The nanoscale dimension and paradigm
3. Nanoscience & Nanotechnology: Fundamentals and classifications
4. Physical and chemical characteristics of Nanomaterials

Unit II

1. Nanoscience: Bottom-up and top-down approach
2. Types of Nanomaterials; one-dimensional: CNTs, its types and characteristics
3. Two-dimensional: Nanofilms, nanosheets, nanowalls
4. Nanocrystal, Nanoparticle, Quantum dot, Quantum Wire

Unit III

1. Nanomaterial and bio system interaction. Quantum effects on nanomaterial
2. Seeing Nanomaterials: Microscopes (SEM, TEM, STM, AFM)
3. Preparation of Nanomaterials: Physical method (hydrothermal and solvothermal) and chemical methods
4. Preparation of Nanomaterials: Biological methods (Green synthesis using plants, microbes & other living organisms)

Unit IV

1. Applications of Nanobiotechnology: nanomedicine, nanocosmetics
2. Nanosensors (Biological, chemical, biosensors, gas sensors, mechanical)
3. Nanomaterials and Diagnostics/Drug Delivery and Therapeutics
4. Current trends of research in nano biotechnology, in health sciences

Unit V

1. Effect of Nano materials on growth and development of plants: bio uptake, Localization, and transformation of nanoparticles within plants
2. Nano agriculture for sustainable agricultural crop production, application and perspectives
3. Nanoparticles for herbicide, pesticides and fertilizers delivery
4. Role of Nanoparticles in Photosynthesis and Toxicity Evaluation

Practical Exercises:

1. Synthesis of nanoparticles by physical method & chemical method.
2. Green synthesis of nanoparticles using plant system from leaves, fruit, callus etc.
3. Characterization of nanoparticles using UV Visible spectroscopy, XRD, FTIR.
4. Visualization of nanomaterials using SEM, TEM.
5. To check the bioactivity of nanomaterials on various pathological Fungi and Bacteria.
6. To check the effect of nanomaterials on plant germination parameters.

Reference Books:

1. Manasi Karkare Nanotechnology: Fundamentals and Applications.2008. I.K.International
2. K. Eric Drexler, Chris Peterson and Gayle Pergamit Unbouding the future: The Nanotechnology Revolution 1991. William Morrow and Company, Inc, New York.
3. C.N.R Rao. Nanoworld: An Introduction to nanoscience and Technology.2010. Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore.
4. ManzerH.Siddiqui, M.H.AI – Whabhi, F. Mohammad (Editors). Nanotechnology and Plant Sciences. 2015, Springer.
5. C.M. Niemeyer and C.A. Mirkin. Nanobiotechnology. 2012. Wiley-VCH.
6. C.M.Niemeyer and C.A. Mirkin Nanobiotechnology-II. 2012. Wiley-VCH.

BT-401: EMERGING TRENDS IN BIOTECHNOLOGY

UNIT I

1. Stem cell Technology: types of stem cells
2. Manipulation of stem cells and applications in medicine
3. Biosensors: Concept, principle and types
4. Biosensors in medicine with suitable example

UNIT II

1. Genomics: concept and general methods of genome analysis
2. Basic concepts of transcripome and transcriptomics
3. Proteome and Proteomics: concept and methods of proteome analysis
4. Basic concepts of metabolome and metabolomics

UNIT III

1. Nano biotechnology: Introduction and biological materials-example and uses
2. DNA nanotechnology, methods of nanoparticles synthesis
3. Nanoparticles-biological arrays-nanoprobes for analytical applications
4. Nano biosensors and its application in medical diagnostics

UNIT IV

1. Microarray Technology and its application
2. Pharmacogenomics and its application
3. Biosafety and animal ethics
4. Drug development strategies

UNIT V

1. Genome editing; concept of CRISPR technology
2. Structure and functions of Cas9
3. CRISPR applications in plants with suitable example
4. CRISPR applications in human therapeutics

Practical Exercises

Appropriate exercises based on theory.

Reference Books

1. DNA Microarrays and gene expression by P. Baldi & GW Hatfield
2. Protein – Protein Interactions by Erica Golemis
3. A passion for DNA (Genesm genomes and Soceity) By JD Watson
4. Modern Genetic analysis by Anthony JF Griffiths et al.
5. Nanobiotechnology- next big idea by Mark, Ratner, Daniel Ratner
6. Gene cloning by TA Brown
7. Latest information on academic Web sites.

BT-402 Project work (semester long dissertation for about 4 months)

BT-403 Seminar

BT-404 Assignment (Technical and review writing)

BT-405 Comprehensive viva-voce