



University College of Science, Mahatma Gandhi University, Nalgonda
M. Sc Biotechnology (2 Year PG Course) CBCS Proposed Scheme with effective from
2023-24 A.Y

Sl. No	Subjects	Credits	Instruction Hrs per Week	Evaluation		Total
				Internalexam+Assignment/ Seminar/GD +Attendance	External Exam	
Semester-I						
1	BT101T. Cell Biology and Genetics	4	4	20 +10+10	60	100
2	BT102T. Biochemistry & Metabolic Regulation	4	4	20 +10+10	60	100
3	BT103T. Microbiology	4	4	20 +10+10	60	100
4	BT104T. Bioanalytical Techniques & Biostatistics	4	4	20 +10+10	60	100
5	BT105P. Cytogenetics & Biochemical Analysis	3	6 (+ 6*)	-	75	75
6	BT106P. Microbiology & Bioanalytical Techniques	3	6 (+ 6*)	-	75	75
	Total	22	28 (+ 12*)	160	390	550
Semester-II						
1	BT201. Molecular Biology & Metagenomics	4	4	20 +10+10	60	100
2	BT202. rDNA technology	4	4	20 +10+10	60	100
3	BT203. Immunology	4	4	20 +10+10	60	100
4	BT204. Bioinformatics & Computational biology	4	4	20 +10+10	60	100
5	BT205P. Molecular Biology & rDNA Technology	3	6 (+ 6*)	-	75	75
6	BT206P. Immunology and Computational Biology	3	6 (+ 6*)	-	75	75
7	Add On Paper: Human Values and Ethics/ Communicative English	2	2	10+5	35	50
	Total	24	28 (+ 12*)	175	425	600
Semester-III						
1	BT301. Plant Biotechnology	4	4	20 +10+10	60	100
2	BT302. Animal Biotechnology	4	4	20 +10+10	60	100
3	BT303A. Cancer biology (or) BT303B. Bio nanotechnology	3	3 (+ 3#)	15+5+5	50	75
4	BT304A. Genomics & Proteomics (or) BT304B. IPR, Management System, Biosafety	3	3 (+ 3#)	15+5+5	50	75
5	BT305P Plant and Animal Biotechnology	3	6 (+ 6*)	-	75	75
6	BT306P Advanced Biotechnology	3	6 (+ 6*)	-	75	75
7	Project Proposal Submission			-	25	25
	ID Paper-Concepts and Applications of Biotechnology for other faculties	2	2	10+5	35	50
	Total	22	26 (+ 6#) (+ 12*)	145	430	575
Semester-IV						
1	BT401. Bioprocess & Fermentation technology	4	4	20+10+10	60	100
2	BT402. Food Biotechnology	4	4	20+10+10	60	100
3	BT403A. Environmental Biotechnology (or) BT403B. Bioentrepreneurship	3	3 (+ 3#)	15+5+5	50	75
4	BT404A Pharmaceutical Biotechnology (or) BT404B Vaccine design & Production technology	3	3 (+ 3#)	15+5+5	50	75
5	BT405P (P-1 & E-I(A/B)	3	6 (+ 6*)	-	75	75
6	BT406P (P-2 & E-II(A/B)	3	6 (+ 6*)	-	75	75
7	Project Final Submission & Presentation	4	@	-	75	75
	Total	24	26(+ 6#) (+ 12*)	130	445	575
	Sem-I	Sem-II	Sem-III	Sem-IV	Total	
No of Credits	22	24	22	24	92	
Marks	550	600	575	575	2300	
Total Workload of Sem-I & III					54 (+ 24*) (+ 6#)	
Total Workload of Sem-II & IV					54 (+ 24*) (+ 6#)	

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te: \$ Workload without ID paper and Project; * Batches are made for practicals if students are more than 0; # if two optional papers are opted by different students; @ 1 hr/week workload for handling of project.

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BT101-CELL BIOLOGY AND GENETICS

UNIT 1: CELL STRUCTURE AND FUNCTION

1.1 Cell Internal organization

- Membrane structure - lipid bilayer and membrane proteins.
- Transport across membranes
- Passive transport: carrier proteins, Ion channels
- Active transport: Na^+ K^+ pump, ionic gradient, ABC transporters, Multi drug resistant efflux forms

1.2 Function of Organelles involved in Cell Energetics and Metabolism

- Mitochondria- Organization and function, Protein import and mitochondrial assembly
Oxidative phosphorylation - electron transport chain, chemiosmotic coupling. Transport of metabolites
Mitochondrial genome.
- Chloroplast- structure and function, Import and sorting of chloroplast proteins,
Photosynthesis - electron flow through PSII and PSI, cyclic electron flow, ATP synthesis.
- Peroxisomes- Structure, functions, assembly, import of proteins.

1.3 Cell communication

- Overview of extracellular signaling.
- Basic characteristics of Paracrine Endocrine, Autocrine systems.
- Tight junctions and Gap Junctions.

1.4 Cell Surface Receptors and Signalling

- G-protein coupled receptor - structure and function, Tyrosine kinase linked receptors, Receptors with intrinsic enzyme activity (RTK)
- Steroid hormones, Peptide hormones, Growth factors
- Second messengers and their role in signal transduction.
- Second messengers cAMP, cGMP, NO
- DAG & IP₃, Role of calcium as second messenger.
- Insulin Signaling pathway, JAK-STAT Pathway

UNIT 2: CELL CYCLE AND CELL PROCESSES

2.1 Cell cycle

- Phases of Cell Cycle
- Discovery of Maturation Promoting factor
- Cyclins, CDKs and their complexes in Yeast and Mammals
- Cell Cycle Inhibitors, Check points in cell cycle, Abnormalities in Cell Cycle – Cancer.

2.2 Cell division

- Mechanics of Cell Division- An over view of M-Phase & Different stages of mitosis.
- Cohesin and Condensin in chromosome segregation.
- Microtubules in spindle assembly, Structure of kinetochore
- Centrosomes and its functions and Sister Chromatid separation.
- Cytokinesis actin & myosin in the generation of contractile ring.
- Meiosis – Stages of Meiosis, Significance Chiasma formation - Synaptonemal complex,
Recombination during meiosis – Recombination nodules

2.3 Cell Death Pathway

- a. Necrosis, Senescence, Autophagic
- b. Apoptosis - Programmed cell death, Biological functions of Apoptosis, Mechanisms of apoptosis.
- c. Caspases, Bcl-2 Proteins, Apoptosis inducing factor.
- d. Apoptosis triggered by internal signals; Apoptosis triggered by external signals.
- e. Cancer: Symptoms and features of cancer cells, Types of Cancer
- f. Tumor suppressor genes, Protooncogenes & Oncogenes
- g. Diagnosis of Cancer, Treatment for Cancer

UNIT 3: MENDELIAN AND NON-MENDELIAN INHERITANCE AND CYTOGENETICS

3.1 Principles of Genetics

- a. Mendel's experiments - Monohybrid ratios- Dihybrid and Tri hybrid ratios –
- b. Laws of independent assortment - Test cross and Back cross.
- c. Incomplete dominance - e.g., Flower Color, Co-dominance - e.g. MN Blood groups.
- d. Pleiotropism, Penetrance and Expressivity - Irregular dominance-e.g.: Polydactyly

3.2 Chromosome organization

- a. Chromosomal Theory of Inheritance. Extension to Mendel's Laws. Multiple Allelism - e.g., Coat color in Rabbits eye color in Drosophila, ABO Blood groups, Rh blood groups – incompatibility and pseudo allelism
- b. Non allelic interactions - Types of Epistasis
- c. Chromosome morphology - Classification – Karyotyping. Features of Centromere and Telomere.
- d. Specialized chromosomes - Polytene & Lamp brush chromosomes.
- e. Euchromatin and Heterochromatin. Chromatin organization - Nucleosome, loops and Scaffolds.

3.3 Sex determination, Pedigree

- a. Sex determination in Drosophila, Birds, Man
- b. X-linked inheritance - Hemophilia, Color blindness, X-inactivation
- c. Y linked inheritance - Holandric genes.
- d. Inheritance patterns in Man - Pedigree analysis

3.4 Chromosomal aberrations

- a. Variation in chromosome number – Euploidy, Aneuploidy.
- b. Variation in chromosome structure
- c. Deletions, duplication translocations and inversions

UNIT 4: LINKAGE, GENE MAPPING AND POPULATION GENETICS

4.1 Linkage and Gene Mapping

- a. Cytological proof of crossing over,
- b. Gene mapping, determination of map distances based on two- and three-point test crosses,
- c. Mitotic Crossing Over, Tetrad analysis – Neurospora.
- d. Gene mapping in man – Genetic mapping, sib pairs, TDT test



4.2 Organellar inheritance

- a. Non- Mendelian Inheritance. Variegation in leaves of higher plants- *Mirabilis Jalapa*
- b. Maternal inheritance - Shell coiling in snails Leber's Optic Atrophy in man.
- c. Uniparental inheritance - mutations in extra nuclear genes in *Chlamydomonas*.
- d. Plasmids, IS element

4.3 Population Genetics

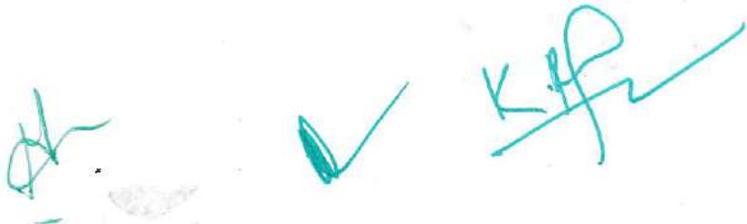
- a. Hardy Weinberg Law
- b. Gene Frequency, Factors Affecting Gene Frequency
- c. Eugenics, Euphenics and Euthenics
- d. Bioethics.

BT 105P- P1: CELL BIOLOGY AND GENETICS PRACTICALS

1. Preparation of Blood Smear and Differential Staining of Blood cells.
2. Isolation of Chloroplasts.
3. Chromatin Extraction and Electrophoresis
4. Study of Mitosis Stages.
5. Study of Meiosis Stages
6. Study of Polyploidy in Onion Root Tips
7. Karyotyping of Normal & Abnormal Chromosome Sets in Humans
8. Solving Problems on Monohybrid and Dihybrid ratios, Multiple alleles, Epistasis.
9. Pedigree Analysis and Inheritance Patterns in Man.
10. Solving Problems on Gene Mapping- Two and Three-point Test Crosses
11. Solving Problems on Tetrad Analysis
12. Preparation of Polytene Chromosomes

REFERENCE BOOKS

1. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication.
2. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York.
3. The Science of Genetics, by A.G. Atherly J.R. Girton, J.F. McDonald, Saundern College publication
4. Principles of Genetics by R.H. Tamarin, International edtn McGrawhill
5. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill
6. Cell & Molecular Biology. E.D.D De Robertis & E.M.F De Robertis, Waverly publication.
7. Molecular Biology of the cell. Alberts, B; Bray, D, Lews, J., Raff, M., Roberts, K and Watson, J.D. Garland publishers, Oxford
8. Molecular Cell Biology Lodish, H., Baltimore, D; Fesk, A., Zipursky S.L., Matsudaride, P. and Darnel American Scientific Books. W.H. Freeman, NewYork
9. Cell and molecular biology by Gerald Karp, Wiley
10. The cell: a molecular approach by Goeffrey Cooper and Robert Hausmann

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BT102. BIOCHEMISTRY & METABOLIC REGULATION

UNIT 1: BIOMOLECULES AND METABOLISM

1.1 Biomolecules & Chemical Basis of life

- Chemical composition and bonding of biomolecules.
- Macromolecules and molecular assemblies – relationship between structure and function, biomolecular hierarchy
- Structure and biochemical organization of amino acids, proteins, carbohydrate, fatty acids, nucleic acids and vitamins.

1.2 Glycoconjugates

- Proteoglycans, Glycoproteins, Glycolipids
- Blood group substances,
- Bacterial cell wall polysaccharides

1.3 Metabolism of Carbohydrates

- Glycolysis & Krebs's cycle - Regulation
- Gluconeogenesis, Glycogenolysis
- Pentose phosphate pathway, Entner-Doudoroff pathway (ED Pathway), Cori cycle

1.4 Photosynthesis

- Photosynthesis, Processes – Light & Dark Reactions
- Photosystem I and II, the electron transport chain
- C3 or Calvin cycle, C4 pathway, CAM pathway, Photorespiration

UNIT 2: AMINO ACIDS, PROTEINS & ENZYMES

2.1 Amino acids

- Amino acids – Classification & Properties,
- Essential & Non-essential amino acids
- Diseases caused by amino acid disorders

2.2 Proteins

- Proteins – Classification & Characteristics, Peptide bond formation
- Structure of proteins - primary, secondary, tertiary, quaternary, Ramachandran's plot, α -helix, β -sheet and collagen structure helix-coil transition, Ramachandran plots, allosteric interactions, cooperative ligand binding in Oxygen transporters, Hill equation
- Post-translational modification, chemical modification of proteins

2.3 Protein - Structural and Functional Relationships

- Stabilization of proteins, Protein crystallization
- Protein degradation and introduction to molecular pathways controlling protein degradation,
- Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.;
- Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.
- Protein metabolism disorders & Diseases



2.4 Enzymes

- a. Structure and components of enzymes
- b. Classification of enzymes
- c. Enzyme Kinetics - Michaelis-Menten equation, Lineweaver-Burke plots

UNIT 3: LIPIDS & MEMBRANES, VITAMINS

3.1 Lipids

- a. Lipids & Fatty acids – Classification & Properties
- b. Digestion & absorption of lipids, Bile acids
- c. Beta-oxidation of fattyacids, ketone bodies

3.2 Membrane Lipids

- a. Phospholipids & glycolipids
- b. Membrane lipids & Bilayers, Membrane biogenesis
- c. Formation of micelles and their importance in drug transport

3.3 Fatty acid metabolism

- a. Fatty acid biosynthesis
- b. Oxidation of unsaturated fatty acids
- c. Lipids & life style diseases, Obesity & Atherosclerosis
- d. Regulation of Triglycerides & Cholesterol metabolism in blood

3.4 Vitamins

- a. Vitamins & their importance, Classification of vitamins
- b. Diseases associated with vitamin deficiencies
- c. Vitamin fortification & supplementation

UNIT 4: STRUCTURE, FUNCTIONS AND METABOLISM OF NUCLEIC ACIDS

4.1 Structure of Nucleic acids

- a. Purines & Pyrimidine's, nucleosides & nucleotides
- b. Watson & Crick model of DNA& Different forms of DNA
- c. Structure and Function of RNA, Types of RNA
- d. microRNA formation, ribozymes

4.2 Functions of Nucleic acids

- a. RNA dependent DNA & RNA synthesis
- b. Recognition of DNA sequences by nucleases, DNA repair molecules
- c. CRISPR/CAS system
- d. Telomeres & ageing

4.3 Nucleotide metabolism

- a. Purine biosynthesis
- b. Pyrimidine biosynthesis
- c. Degradation pathways of nucleotides

BT 105P- P2: BIOCHEMISTRY & METABOLIC REGULATION PRACTICALS

1. Preparation of buffers and measurement of pH
2. Qualitative tests for sugars
3. Qualitative tests for amino acids
4. Estimation of total proteins by biuret reagent
5. Qualitative tests for lipids
6. Estimation of DNA by the Diphenylamine Method
7. Estimation of RNA by the orcinol Method
8. Estimation of chlorophyll content in plant sample.

REFERENCE BOOKS

1. Lehninger's principles of Biochemistry (David L. Nelson and Michael M. Cox)
2. Biochemistry (Jeremy M. Berg, John L. Tymoczko, Lubert Stryer)
3. Biochemistry (Donald Voet and Judith G. Voet)
4. Molecular biology of the cell. New York: Garland Science [Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002)]



BT 103. MICROBIOLOGY

UNIT 1: HISTORY, GENERAL CHARACTERISTICS OF MICROORGANISMS & MICROBIAL NUTRITION

1.1 History and Microscopy

- a. The concept of Microbial origin of Fermentations. Historical developments in Microbial Biotechnology
- b. Microscopy and Types of Microscopes - Principles and working of Bright field, Fluorescent, Phase Contrast and Electron microscopes

1.2 General characteristics of microorganisms

- a. Classification of microorganisms; Diversity of microorganisms – Bacteria, Mycobacteria & Mycoplasma, Archaea, Fungi, Algae, Protozoa, Virus
- b. General characteristics of Algae (Cyanophyta, Chlorophyta, Phaeophyta, Rhodophyta); Economic importance of Algae (agriculture, industry, medicine)
- c. General characteristics of Fungi (Phycomycetes, Basidiomycetes, Ascomycetes, Deuteromycetes); Economic importance of Fungi; Pathogenic Fungi (Humans)
- d. General characteristics of Protozoa; Entamoeba and Plasmodium as human pathogens

1.3 Microbial Nutrition

- a. Nutrition in Microorganisms and assimilation of nutrients.
- b. Nutritional groups of microorganisms. Microbiological media and their applications

UNIT 2: BACTERIA AND THEIR CHARACTERISTICS

2.1 General characters & Identification of Bacteria

- a. General characters of Bacteria
- b. Identification of bacteria – conventional methods - simple staining, differential staining, structural staining, Special staining methods
- c. Molecular approaches for bacterial identification – PCR & Genome sequence based

2.2 Isolation of bacteria

- a. General methods for isolation of bacteria - Serial dilution technique
- b. Plating methods – Pour plate method, Spread plate & Streak plate techniques
- c. Membrane filter technique

2.3 Cultivation and Growth of bacteria

- a. Bacterial growth - typical growth curve - batch and continuous cultures, synchronous cultures
- b. Measurement of bacterial growth- measurement of cell number and cell mass
- c. Factors influencing bacterial growth- temperature, pH, water activity, Oxygen concentration, salt concentration, pressure and radiation

2.4 Pure cultures of bacteria

- a. Concept of pure culture, methods of pure culture
- b. Enrichment culturing techniques, Single cell isolation
- c. Pure culture development

2.5 Microbial diseases & diagnosis

- a. Diseases caused by bacteria in humans - *Staphylococcus*, *Streptococcus*, *Mycobacterium tuberculosis*
- b. Infectious disease and their transmission - Air, Water, Vector-Borne, Food-Borne, Zoo borne
- c. Different diagnostic tests for different microorganisms - WIDAL, CAMP, CLO, ALA, Salt Broth test, Acetate Utilization Test, Bile Solubility Test

UNIT 3: Control of microorganisms and Preservation of microbial cultures

3.1 Sterilization

- a. Disinfection, Antisepsis and Sterilization and their applications
- b. Methods of sterilization - dry heat, moist heat, radiation methods, filtration methods, chemical methods
- c. Sterilization at industrial level – Steam sterilization, Flash sterilization, Low temperature sterilization, Gas sterilization.
- d. Kinetics of thermal death of cells & spores.

3.2 Containment and antimicrobial agents

- a. Concept of Containment facility – Primary and Secondary containment; Biosafety Levels
- b. Types of antimicrobial agents – Sulfonamides, Antibiotics (Penicillin, Cephalosporin etc.)
- c. Development of microbial resistance to various antimicrobial agents; types of mechanisms

3.4 Preservation of microbial cultures

- a. Principles of preservation of microbial cultures
- b. Methods of preservation of microbial cultures- repeated subculturing, preservation at low temperature, Sterile soil preservation, mineral oil preservation, deep freezing, Liquid nitrogen preservation, freeze-drying (lyophilization)
- c. Importance of preservation of microbial cultures in industry

UNIT 4: Viruses and their characteristics

4.1 General characters & Classification

- a. History of Virology
- b. General characteristics, classification and nomenclature of viruses
- c. Importance of Viruses in Biotechnology

4.2 Bacteriophages

- a. Structure & Replication of Bacteriophage (T2)
- b. Characteristics & importance of M13 phage
- c. Lambda phage - Lytic and Lysogenic cycles

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4.3 Isolation, purification & detection of viruses

- a. Isolation and Purification of viruses by Filtration
- b. Isolation and Purification of viruses by Precipitation and Centrifugation
- c. Detection of viruses: physical, biological, immunological and serological methods

4.4 Cultivation of viruses

- a. Purpose of cultivation of viruses
- b. Methods of cultivation of viruses
- c. Cell culture method - animal cell inoculation & chick embryo

4.5 Structure & characteristics of important viruses

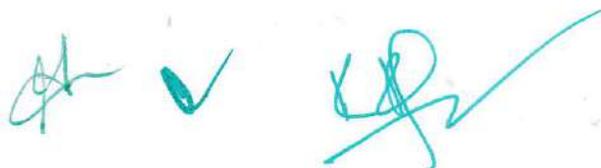
- a. Structure and characteristics of plant viruses - TMV, CaMV, RTBV
- b. Structure and characteristics of Hepatitis virus, Polio virus, HIV
- c. Structure and characteristics of Corona and Influenza viruses

BT 106P- P3: MICROBIOLOGY PRACTICALS

1. General instructions of microbiology laboratory; Microscopic observation
2. Preparation of microbiological media – minimal media, basic media
3. Preparation of enriched media, enrichment media, differential media
4. Preparation of fungal culture media – potato dextrose agar
5. Sterilization of media – autoclave, filtration
6. Staining techniques for bacteria – simple staining,
7. Staining techniques for bacteria – Gram's staining
8. Staining techniques for fungi – Lactophenol Cotton blue staining
9. Isolation & identification of pure culture of bacteria
10. Preservation & maintenance of pure cultures of microbes – slant & stab cultures
11. Culturing of microbes – tube culture, flask culture, shake flask culture
12. Study of bacterial growth curve
13. Bacterial antibiotic sensitivity analysis
14. Isolation and culture of fungi/algae

REFERENCE BOOKS

1. Microbiology by M.J. Pelzar, E.S.N. Cfan and N.R. Kreig, McGraw Hill Publ.
2. Introductory Microbiology by J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge University Press.
3. University Press.
4. General Microbiology by H.G.Schlegel Cambridge University Press.
5. General Microbiology by Stanier, R.Y, J.L. Ingrahm, M.L. Wheel is & P.R. Painter.
6. Microbiology– Concepts and Application. John Wiley and Sons,

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BT104. BIOANALYTICAL TECHNIQUES & BIOSTATISTICS

Unit 1: BIOSTATISTICS

1. Introduction to Biostatistics

- Methods of sampling, types of samples
- Measures of average & variation - Measures of dispersion (Range, standard deviation, mean deviation, variance, Coefficient of variation), Skewness and Kurtosis
- Measures of central tendency (mean, median, mode)

1.2. Probability

- Concept of probability, Laws of probability (Addition and multiplication laws)
- Bayes theorem and its applications
- Probability distributions: Features and applications of Binomial, Poisson and Normal Distribution

1.3. Tests of Hypothesis

- Null and alternate hypothesis, test of significance, p-value
- Test statistics: Z test (for proportions and means), t-test (students t-test, paired t test)
- Analysis of categorical data: Chi-square test (test for goodness of fit, homogeneity test, linkage, test of independence); non-parametric tests

1.4. Multivariate analysis

- Analysis of variance - One way and Two-way Anova (F- test)
- Correlation analysis Pearson's correlation, Spearman's Correlation
- Regression analysis - simple and multiple regressions

Unit 2: BIO-ANALYTICAL TECHNIQUES

2.1 Spectroscopy I Techniques

- Laws of absorption of light, Beer-Lambert's Law
- UV, Visible Spectroscopy Circular dichroism spectroscopy
- Fluorescence & IR spectroscopy, Raman Spectroscopy

2.2 Spectroscopy II Techniques

- NMR & MRI - Types & applications
- Mass spectra & its applications
- ESR & PET, applications

2.3 Spectrometric Techniques

- MALDI- TOF
- Flow cytometry
- ELISA



2.4 Bio- analytical Assays

- a. Ultrafiltration
- b. Dialysis – Laboratory & Industrial applications
- c. Dialysis – Medical applications

UNIT 3: CENTRIFUGATION, CHROMATOGRAPHIC AND ELECTROPHORESIS TECHNIQUES

3.1 Centrifugation Techniques

- a. Principles of sedimentation
- b. Centrifuge & Rotors
- c. High speed centrifuge & Ultracentrifuge

3.2 Chromatographic Techniques

- a. Chromatography, Paper & TLC
- b. Column chromatography
- c. Ion exchange chromatography, Affinity chromatography
- d. HPLC
- e. LC-MS, Gas chromatography
- f. Applications of chromatography

3.3 Electrophoresis Techniques

- a. Basis of electrophoresis
- b. Agarose electrophoresis, Pulse field electrophoresis
- c. PAGE – SDS & Native

UNIT 4: BLOTTING, IMAGING AND RADIOACTIVITY TECHNIQUES

4.1 Blotting Techniques

- a. Southern blotting
- b. Western blotting
- c. Northern blotting

4.2 Imaging Techniques

- a. Generation of X-rays
- b. X-ray diffraction and applications
- c. X-rays – Application in medicine

4.3 Radioactivity and its Measurement

- a. Radioactive decay, measurement of radiation
- b. Geiger-Muller counter
- c. Scintillation counter

4.4 Radioisotopes in Medicine

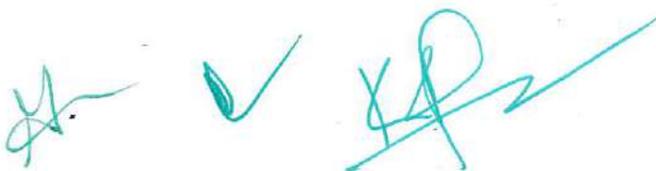
- a. Radioisotopes used in medicine
- b. Radiation therapy
- c. carbon dating

BT 106P- P4: BIOANALYTICAL TECHNIQUES & BIOSTATISTICS PRACTICALS

1. Estimation of Mean, Median, Mode, Standard deviation, Variance, coefficient of variation and standard error for grouped and ungrouped data
2. Problems on probability, Problems on Binomial and Poisson distributions and Problems on Normal distribution
3. Hypothesis testing using t-test: Paired t-test, Unpaired t-test
4. Hypothesis testing using Chi-square test
5. Hypothesis testing using F test: Problems on one-way ANOVA
6. Hypothesis testing using F test: Problems on two-way ANOVA
7. Instrumentation - Colorimeter & Spectrophotometer, validating the Beer- Lambert's Law
8. Paper chromatography
9. TLC
10. Column chromatography
11. SDS-PAGE
12. Agarose electrophoresis
13. Estimation of RPM & G-force
14. Western blotting of proteins

REFERENCE BOOKS

1. Quantitative Genetics by Falconer
2. Biostatistics by Vishweswara Rao
3. Biostatistics by Khan and Khanum
4. Fundamentals of Biostatistics by P.H. Rao and Janardhan
5. Population Genetics by V. Venugopal and Pratibha Nallari
6. Biostatistical Methods in Agriculture Biology and Medicine by Khan and Khanum
7. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
8. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
9. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
10. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
11. Selected readings from Methods in Enzymology, Academic Press.



UNIT 1: GENOME ORGANIZATION

1.1 Genetic Material & Structure

- a. DNA as Genetic Material - Historical Account
- b. RNA as Genetic Material
- c. Structure of DNA (Watson and Crick model), Forms of DNA – A, B & Z, Supercoiled DNA

1.2. Genome Organization & Genome Complexity

- a. Packaging of Viral genome (RNA & DNA viruses), Prokaryotic genome organization – Nucleoid; features, size
- b. Eukaryotic genome organization – Nucleosome, 30 nm fibre, Solenoid loops, Chromosome (Centromere & Telomere); Euchromatin & Heterochromatin
- c. Genome Complexity – Genome Size, Chromosome Number, Gene Size, Gene Density, C-value Paradox

1.3. Non repetitive & Repetitive DNA, Transposons

- a. Melting of DNA & Reassociation Kinetics; Unique sequences
- b. Repetitive DNA – Interspersed & Tandem repeats, Minisatellites & Microsatellites
- c. Transposons – types and mechanisms of transposition; Retrotransposons – Class I & II, Retrogenes, Role of Transposons in genome evolution.

1.4. Gene Families, Gene duplication & amplification

- a. Gene families; Tandem array Gene families; Clustered Gene families – Globin Gene & Histone Gene Clusters
- b. Gene Duplication; Pseudogenes – processed & nonprocessed
- c. Gene Amplification – Mechanism & Significance of Gene Amplification

1.5. Extrachromosomal & Organellar Genomes

- a. Organization of plasmid DNA – bacteria, Yeast
- b. Organization of Mitochondrial genome - features, size and contents of genome
- c. Organization of Chloroplast genome - features, size and contents of genome

UNIT 2: GENOME REPLICATION, DAMAGE, REPAIR AND RECOMBINATION

2.1 DNA replication, regulation

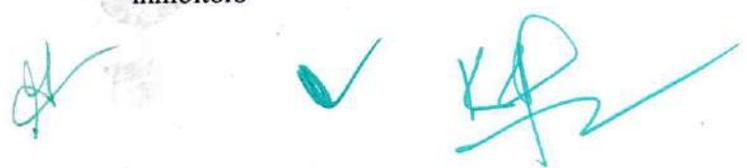
- a. Modes of DNA replication – Semiconservative mode (Meselson & Stahl Experiment)
- b. Replication Origin & Replication fork; Okazaki fragments, Fidelity of replication
- c. Enzymes and proteins involved in DNA replication
- d. Replication of Prokaryotic and Eukaryotic Genome
- e. Regulation of eukaryotic DNA replication

2.2 Extrachromosomal & Organellar genomes

- a. Replication of plasmid DNA – θ model, rolling circle model
- b. Replication of mitochondrial genome - D loop model
- c. Replication of chloroplast genome – double D loop model

2.3 Errors & Inhibitors of DNA Replication

- a. Replication associated errors - Tautomeric shifts, Wobble
- b. Replication associated Strand slippage
- c. Inhibitors of DNA replication – Nucleoside analogues, DNA Topoisomerase inhibitors



2.4 DNA Damage, Repair & Recombination

- a. Mutations, DNA damage
- b. DNA Repair mechanisms
- c. Recombination, Homologous recombination Site-specific recombination; non-homologous end joining recombination
- d. Mechanism and regulation of meiotic recombination
- e. Genome rearrangements & Genome instability

UNIT 3: METAGENOMICS- APPROACHES, ANALYSIS AND CHALLENGES

3.1 From genomics to metagenomics

- a. History of the culture divide, 16S rRNA analysis and culturing, culture independent insight.
- b. Global impact of metagenomics,
- c. Next generation of DNA sequencing technologies and potential challenges
- d. The developments and impact of 454 and Solexa sequencing.

3.2 Approaches to metagenomics analysis

- a. 16S rRNA based survey, 16S rRNA – microarray (phylochip)
- b. Sequence base analysis, functional based analysis, heterologous expression
- c. Identifying active clones - clone screens, selection and functional anchors, identifying habitats and collecting metadata, gene expression system, single cell analysis
- d. Stable isotope probing and oligonucleotide microarrays -
Direct linking of microbial populations to specific biodegradation and biotransformation processes by stable isotope probing of biomarkers-
PhyloChip&GeoChip-Detection of xenobiotic-degrading bacteria by using oligonucleotide microarrays

3.3 Bioinformatics challenges of metagenomics

- a. Genomics data, metagenomics data, the importance of metadata, databases for metagenomics data
- b. Software, analysis of metagenomics sequence data.
- c. Viral metagenomics, large scale sequencing of mammoth DNA
- d. Metagenomics of gut: insects, mouse and human beings

UNIT 4: METAGENOMICS STUDIES AND APPLICATIONS

4.1 Metagenomics case studies

- a. Metagenomic analysis of soil microbial communities
- b. Metagenomic analysis of marine microbial communities
- c. Metagenome of the Microbial Community in Acid Mine Drainage
- d. Metagenomic Analysis of Bacteriophage
- e. Metagenomics and Its Applications to the Study of the Human Microbiome
- f. Archaeal Metagenomics: Bioprospecting Novel Genes and Exploring

4.2 Metagenomics in environmental studies

- a. Application of Metagenomics to Bioremediation
- b. Applications of Metagenomics for Industrial Bioproducts
- c. Escherichia coli host engineering for efficient metagenomic enzyme discovery;
- d. DNA sequencing of uncultured microbes from single cells



4.3 Application of Metagenomics

- a. Technical advancement in the field
- b. Application and expected benefits from large scale metagenomics data
- c. Application in human health, agriculture, industry and environment remediation.

BT 205P-P1: MOLECULAR BIOLOGY AND METAGENOMICS PRACTICALS

1. Agarose Gel Electrophoresis
2. Genomic DNA Isolation from Plants
3. RNA Isolation
4. Plasmid DNA Isolation
5. Determination of purity and concentration of Nucleic acids
6. Restriction Digestion of Lambda Phage DNA
7. RFLP
8. cDNA synthesis

REFERENCE BOOKS

1. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter.
2. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W. Robertis, A. Steitz & A.M. Weiner, Benjamin Cummings Publ. California
3. Molecular Cell Biology Lodish, H., Baltimore, D; Fesk, A, Zipursky S.L., Matsudaride, P. and Darnel American Scientific Books. W.H. Freeman
5. Genes VII. Benjamin Lewis, Oxford Univ. Press, Oxford
6. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford
7. Molecular Biology by T.A. Brown
8. Essentials of Molecular Biology. D. Freifelder, Panima publishing co-operation
9. Genes & Genomes – A changing perspective by Singer & Berr, Universal Science Books, California.
10. DNA Damage Repair, Repair Mechanisms and Aging by Allison E. Thomas Nova Science Publisher's, 2010.
11. Chromosomal Translocations and Genome Rearrangements in Cancer by Janet D. Rowley, Michelle M. Le Beau, Terence H. Rabbitts Springer International Publishing, 2015.
12. The New Science of Metagenomics: Revealing the secrets of our microbial planet, Academic press, Washington DC, USA
13. Metagenomics: Sequence from the Environment, NCBI
14. Next generation DNA sequencing, Nature Publishing Group, (Vol. 26 No.10 , Oct, 2008)

BT 202. R DNA TECHNOLOGY

UNIT1: ENZYMES IN MOLECULAR CLONING

1.1 Restriction Enzymes

- a. Exonuclease and Endonuclease
- b. Discovery of Restriction enzymes
- c. Classification of Restriction Endonucleases
- d. Features of Restriction Endonucleases.

1.2 DNA and RNA Modifying enzymes

- a. Methylases, Ligases, Kinases, Phosphatases, Nucleases
- b. Klenow fragment
- c. Taq DNA Polymerase
- d. RNA dependent DNA polymerase
- e. Terminal Deoxynucleotidyl transferase
- f. T7 RNA Polymerase, T7 DNA Polymerase and Sequenase
- g. Linkers, Adopters, Homopolymer tailing

UNIT 2: VECTORS IN MOLECULAR CLONING

2.1 Cloning Vectors and Expression Vectors

- a. Natural Plasmids
- b. pBR322, pUC18. T/A Vector, pET21
- c. Bacteriophage vectors –Insertional and Replacement vectors
- d. M13 based Vectors
- e. Cosmids, Phagemids, Phasmids
- f. Yeast vectors and Pichia Expression vectors
- g. Baculo virus vector, Plant Vectors, Viral Vectors, Mammalian Vectors

UNIT 3: CONSTRUCTION OF GENOMIC, cDNA LIBRARIES AND TECHNIQUES EMPLOYED

3.1 Gene cloning strategies

- a. DNA cloning methods

3.2 Construction of Genomic and cDNA Libraries

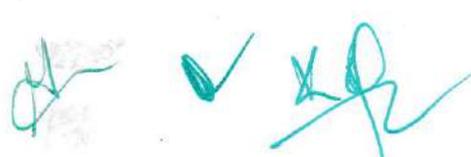
- a. Strategies for construction of genomic libraries
- b. Chromosome walking
- c. cDNA synthesis
- d. Strategies for construction of cDNA libraries
- e. Normalized cDNA libraries, Subtraction cDNA libraries

3.3 Nucleic acid Hybridization techniques

- a. Labelling of Nucleic acids and proteins
- b. Blotting and Hybridization techniques- Southern, Northern & Western
- c. Zoo blots and Colony hybridization

3.4 DNA and RNA Sequencing Methods

- a. Maxam and Gilbert method
- b. Sanger's methods & Pyrosequencing,
- c. Next generation Sequencing
- d. RNA Seq -Transcriptomics



UNIT 4: SELECTION, ANALYSIS AND APPLICATIONS OF RECOMBINANT CLONES

4.1 Genetic selection and analysis of recombinant clones

- a. alpha complementation
- b. Insertional inactivation.
- c. Restriction mapping of cloned fragments.
- d. S1 Nuclease Mapping.
- e. Hybrid arrest and Hybrid released translation.
- f. Site directed mutagenesis.

4.2 Analysis of recombinants by PCR technology

- a. Reverse PCR & Real Time PCR
- b. PCR applications

4.3 Gene expression analysis

- a. Heterologous gene expression or Cloned gene expression.
- b. Factors influencing cloned gene expression

4.4 Applications of rDNA technology

- a. siRNA & Gene Silencing
- b. Genetic Engineering of organisms – Plants, Animals, Bacteria, Viruses and Yeast(include 2 examples of each)
- c. Synthetic Biology and Applications

BT 205P-P2: R DNA TECHNOLOGY PRACTICALS

1. Preparation of Competent Cells
2. Transformation of pUC18 into E.coli
3. Primer design
4. Amplification of genomic DNA by PCR technique
5. Restriction digestion DNA and size determination of the fragments
6. Double digestion of DNA and restriction mapping
7. Cloning of foreign DNA fragments into E. coli
8. Selection of recombinant clones by alpha complementation / insertional inactivation
9. Analysis of recombinant clones

REFERENCE BOOKS

1. Principles of Gene manipulation (1994) Old R.N. and Primrose S.B.
2. From Genes to Clones (1987) Winnaeker E.L.
3. Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. and Zooller M.
4. An Introduction to Genetic Engineering: Nicholl, D.S.T.
5. Molecular Biotechnology (1996) Pasternak
6. The Biochemistry of Nucleic acid(1996)Adam et al
7. Genetic Engineering (1998)Janke k. swtlow

BT 203. IMMUNOLOGY

UNIT 1: BASICS PRINCIPLES OF IMMUNOLOGY

1.1 Immunity- Types of Immunity

- a. Innate immunity - Anatomic barriers, physiological barriers, phagocytic barriers, microbial antagonism, inflammation
- b. Acquired Immunity- Types & characteristics
- c. Deficiencies of innate immune mechanisms- Chronic Granulomatous Disease (CGD), Leukocyte-adhesion deficiency (LAD)

1.2 Cells of the Immune System

- a. Haematopoiesis and differentiation
- b. Lymphoid cells (B & T-Lymphocytes; T cell subsets; NK cells)
- c. Myeloid cells: Mononuclear phagocytes (monocytes, macrophages) Granulocytes (neutrophils, eosinophils, basophils, mast cells, dendritic cells)

1.3 Organs of the immune system

- a. Primary lymphoid organs (Bone marrow and Thymus)
- b. Secondary lymphoid organs (Lymph nodes, Spleen)
- c. Mucosal-associated lymphoid tissue and Cutaneous associated lymphoid tissue

UNIT - 2 ANTIGENS AND IMMUNOGLOBULINS

2.1 Antigens & Complement system

- a. Immunogenicity versus Antigenicity, Factors that influence immunogenicity
- b. Epitopes- Properties of B cell epitopes and T cell epitopes & Haptens
- c. Functions and components of complement system; complement activation

2.2 Basic structure of Immunoglobulin & its functions

- a. The role of multiple myeloma in understanding Ig structure
- b. Fine structure of Immunoglobulins- Immunoglobulin domains-variable region and constant region domains
- c. Immunoglobulin classes- IgG, IgM, IgA, IgD and IgE; functions of Ig classes
- d. Antigenic determinants on immunoglobulins

2.3 Organization of Immunoglobulins

- a. Antigenic determinants on Immunoglobulins
- b. Effector functions of antibodies
- c. Organization and expression of immunoglobulin light and heavy chain genes

2.4 Antigen-antibody reactions

- a. Precipitation
- b. Agglutination

2.5 Antibody engineering & its applications

- a. Polyclonal antibodies production & its applications
- b. Monoclonal Antibodies Production & its applications
- c. Antibody engineering- human antibodies from phage display



UNIT 3: B CELL ACTIVATION, MAJOR HISTOCOMPATIBILITY COMPLEX (MHC) AND HLA

3.1 B-cell activation & differentiation

- a. B-cell activation and proliferation by Thymus Independent and Thymus Dependent
- b. antigens
- c. B-cell differentiation, class switching and generation of plasma cells and memory cells
- d. B-cell immunodeficiency disorders – X-linked gamma globulinemia, selective immunoglobulin deficiency

3.2 Major Histocompatibility Complex (MHC)

- a. General organization and inheritance of MHC; MHC Haplotypes
- b. The structure of MHC Class I and Class II molecules
- c. Organization of MHC Class I and Class II genes, peptide binding of MHC molecules

3.3 MHC immune responsiveness & HLA

- a. Polymorphism of MHC Class I and Class II molecules
- b. Cellular distribution of MHC molecules, MHC molecules and immune responsiveness and disease susceptibility
- c. Types of grafts, Mechanism of graft rejection, immunological basis of graft rejection, Graft versus host reactions & Role of HLA typing in organ transplantation
- d. Human leukocyte antigen (HLA) typing by mixed lymphocyte reaction (MLR), microcytotoxicity tests and by PCR

UNIT 4: CELL-MEDIATED IMMUNE RESPONSES

4.1 Antigen presentation

- a. Antigen processing by antigen presenting cells
- b. Structure and functions of T cell receptors (TCR)
- c. TCR-peptide-MHC tri-molecular complexes

4.2 Role of cytokine in immune responses

- a. Cytokines– properties; cytokine receptors
- b. Th1 and Th2 type of cytokines
- c. Therapeutic uses of cytokines

4.3 Cell- mediated cytotoxic responses

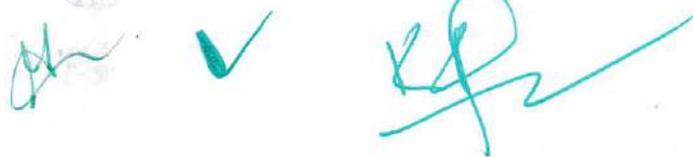
- a. Cell-mediated immune response: General properties of effector T cells
- b. Direct Cytotoxic response
- c. Experimental assessment of cell-mediated Cytotoxicity

4.4 Hypersensitivity & Autoimmunity

- a. Hypersensitivity and its types
- b. Delayed Type Hypersensitivity (DTH) and cytokines involved in DTH
- c. Auto-immunity– mechanisms and auto-immune diseases-Insulin Dependent Diabetes; Rheumatoid Arthritis, Auto-immune Thyroid disease, Systemic lupus erythematosus (SLE)

4.5 Immunodeficiency disorders

- a. T cell primary immunodeficiency disorders– Severe combined immunodeficiency (SCID); Di George syndrome
- b. Secondary immunodeficiency disorders- acquired immune deficiency syndrome (AIDS)

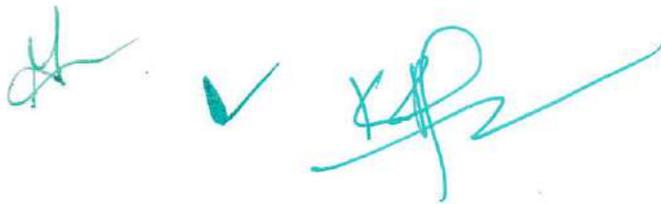


BT 206P-P1 IMMUNOLOGY PRACTICALS

1. ABO blood typing
2. Micro-hemagglutination Test
3. Isolation of Plasma
4. Isolation of Serum
5. Serum Protein Electrophoresis
6. Single radial Immunodiffusion
7. Double diffusion
8. Dot ELISA
9. Western Blot by Enzyme-conjugated antibody
10. Sandwich Enzyme Linked Immunosorbent Assay
11. HLA Typing by PCR
12. Isolation of lymphocytes by histopaque & cell viability test by Trypan Blue
13. MTT Assay
14. Principle and procedure for enumeration of specific cell types by Fluorescent Activated Cell Sorter (FACS)

REFERENCE BOOKS

1. Essential Immunology- By I. Roitt, Publ: Blackwell
2. Immunology- By G. Reeve & I. Todd, Publ: Blackwell
3. Immuno diagnostics- By S.C. Rastogi, Publ: New Age
4. Immunology: By Richard A. Golds, Thomas J Kindt, Barbara A. Osborne, Janis Kuby
5. Fundamental immunology- By William E. Paul.
6. Basic Immunology- By Bhoosreddy G.L. and Wadher B.J.
7. Text book of immunology- By Baruj Benacerraf

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BT204. BIOINFORMATICS & COMPUTATIONAL BIOLOGY

UNIT 1: DATABASES

1.1 Introduction to System Biology

- a. History & development of Bioinformatics
- b. Types of data – Nucleotide & Protein
- c. Tools & resources

1.2 Data Storage & Retrieval, Databases

- a. Accessing Nucleotide sequence databases
- b. NCBI, Pubmed,
- c. EMBL, DDBJ

1.3 Proteomic Databases

- a. Protein sequence databases
- b. NCBI, Protein Data Bank (PDB), PIR
- c. UNIPROT, UNIGENE

1.4 Specialized databases

- a. Specialized databases
- b. Pfam, SCOP, GO
- c. Metabolic Pathways

UNIT 2: ALGORITHMS FOR NUCLEOTIDE AND PROTEIN SEQUENCE ANALYSIS

2.1 Sequence alignment

- a. Dot matrix comparison
- b. Nucleotide
- c. Protein

2.2 Scoring Analysis

- a. Sequence alignment scores, scoring matrix
- b. E value, P value
- c. Gap penalty

2.3 Sequence Analysis

- a. BLAST & FASTA
- b. Paired sequence analysis
- c. Multiple sequence analysis

2.4 Molecular Phylogenetics

- a. Phylogenetic analysis
- b. Construction of a phylogenetic tree
- c. Applications

UNIT 3: STRUCTURAL BIOINFORMATICS

3.1 Protein structure analysis

- a. Protein structure classification
- b. Secondary structure determination
- c. Ramachandran plot

3.2 Protein secondary structure classification databases

- a. Protein structure visualization tools
- b. SCOP
- c. CATH, KEGG

3.3 Sequencing Tools

- a. Genome sequencing
- b. DNA sequencing
- c. RNA sequencing

3.4 Mapping Genomes

- a. Genome map construction
- b. DNA
- c. Protein

UNIT 4: DRUG DESIGNING

4.1 Fundamentals of Molecular Modelling and Drug Design

- a. Drug discovery & Drug design
- b. Molecular modelling
- c. QSAR

4.2 Molecular Docking

- a. Docking studies
- b. Rigid docking
- c. Flexible, manual docking

4.3 Docking Analysis Tools

- a. AUTODOCK
- b. VINA
- c. SWISS DOCK

4.4 Microarray Technology

- a. Microarrays
- b. Disease profiling
- c. Applications

BT 206P-P2: BIOINFORMATICS & COMPUTATIONAL BIOLOGY PRACTICALS

1. Introduction to computers
2. Pubmed & NCBI
3. Swissprot
4. Construction of Ramachandran plot
5. How to use KEGG
6. Auto dock
7. Phylogenetic tree construction
8. BLAST & FASTA

REFERENCE BOOKS

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevasis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

SEMESTER- III

BT301- PLANT BIOTECHNOLOGY

UNIT I : PLANT TISSUE CULTURE TECHNIQUES

1. Plant Cell Totipotency, Dedifferentiation, Redifferentiation, Plant Morphogenesis
2. Plant Culture Media – , Sterilization of media, Types of media – White's media, B5 media, MS media; Growth regulators – Auxins, Cytokinins, Gibberellines, Abscisic acid, Ethylene
3. Initiation of Callus cultures & Cell suspension cultures and Plant regeneration
4. Micropropagation – process, methods, advantages and applications
5. Somaclonal Variation - causes, molecular basis and applications
6. Production of haploids – Anther culture, Pollen culture
7. Dihaploids production & their applications
8. Embryo culture and Embryo rescue
9. Isolation and culture of protoplasts; Fusion of protoplasts (homokaryons & heterokaryons)
10. Somatic hybridization, selection & characterization of hybrids, their applications.
11. Cryopreservation – different methods, advantages & applications

UNIT II: PLANT SECONDARY METABOLITES

1. Plant secondary metabolites – classification & uses
2. *In vitro* plant cell & tissue cultures as source of secondary metabolites
3. Biotransformation and production of novel compounds
4. Chemical Factors – media, nutrients, Growth regulators, Precursor feeding
5. Physical Factors – Light, pH, Temperature, gaseous environment
6. Biological Factors – Stages of cell cultures, Degree of differentiation
7. Permeabilization and immobilization for enhanced production of secondary metabolites
8. Elicitation (Abiotic & Biotic Elicitors) for enhanced production of secondary metabolites
9. Adventitious shoots, roots and hairy root cultures
10. Hairy root cultures
11. Pathway engineering for secondary metabolites

UNIT III : GENETIC MODIFICATION TECHNIQUES

1. Agrobacterium mediated gene transfer technique – Ti plasmid, molecular basis of Agrobacterium infection; Binary & Cointegrate vectors
2. Direct gene transfer techniques – Particle Bombardment, Electroporation, Microinjection
3. Virus mediated gene transfer – VIGS
4. Screening of transformants using reporter genes – *GUS*, *GFP*
5. Selection of transformants using selection marker genes – antibiotic (*npt II*, *hpt II*) or herbicide (*bar*, *ppt*) resistance marker genes
6. Chloroplast transformation – advantages & applications
7. RNAi Technology – role in crop improvement
8. Genome Editing Technique – CRISPR CAS 9

UNIT- IV: GENETIC MODIFICATION APPLICATIONS

1. Abiotic stress tolerance –Heat , Drought, Salinity and Heavy metal stress tolerance
2. Biotic stress – Bacterial, Fungal (LBR GM Potato) & Viral resistance (Rainbow Papaya)
3. Insect and Herbicide resistance (BT Cotton, GM Mustard-DMH-11)
4. Production of crops with improved growth & productivity
5. Production of biopharmaceuticals and therapeutics by transgenic plants (Insulin, Interferons, Growth hormones) & Vaccines (Edible vaccines)
6. Production of crops with improved nutrition (amino acids- LY038 Corn, High-oleic soyabean oil, VitaminA- Golden Rice1 and Golden Rice 2 & micronutrients- Biofortified Cassava)

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REFERENCE BOOKS

1. Plant tissue culture and its biotechnological applications by W. Barz, E. Reinhard, M.H. Zenk
2. Plant tissue culture by Akio Fujiwara
3. Frontiers of plant tissue culture by Trevor A. Thorpe
4. In vitro haploid production in higher plants by S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant tissue culture: theory and practice by S.S. Bhojwani and A. Razdan
6. Plant cell, tissue and organ culture, applied and fundamental aspects by Y.P.S. Bajaj and A. Reinhard

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BT302 - ANIMAL BIOTECHNOLOGY

UNIT I: Animal Cell, Tissue and Organ Culture

1. History of Animal Cell culture: Ross Granville Harrison, George Gey
2. Steps for preparation of cell culture room
3. Culture Environment (Substrates and types of Media)
4. Techniques for establishing of cell lines.
5. Insect cell culture, Organ and embryo culture
6. Cryo preservation valuable products.
7. Artificial insemination (IUI, ICSI)
8. Embryo transfer - cloning (MOLLY and POLLY).
9. Nuclear transplantation, Invitro fertilization technology
10. Genetic Engineering in animal cell lines
11. Cloning vectors: Animal Viral Vectors
12. Mammalian Expression vectors
13. Transformation of animal cells

UNIT II: Stem Cells and Application

1. The biology of stem cells
2. Different types of stem cells – embryonic stem cells, fetal tissue stem cells,
3. Cord blood stem cells
4. Adult stem cells and stem cell differentiation
5. Isolation and propagation of embryonic stem cells and their preservation
6. Hematopoietic stem cells and bone marrow transplantation
7. Cells for hematopoietic reconstitution
8. Cells for adoptive cellular immunotherapy
9. Clinical applications of stem cell therapy
10. Stem cell therapy for eye diseases
11. Neurodegenerative diseases – Parkinson's disease
12. Alzheimer's disease, spinal cord injury and other brain syndromes
13. Embryonic stem cell uses in endangered animals.

UNIT III: Molecular Markers and Animal genomes

1. DNA markers- RAPD, STR, SSCP
2. RFLP, DNA fingerprinting, SNP, EST
3. FISH technique and *In situ* hybridization in gene mapping and applications
4. Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing.
5. Genetic distance analysis
6. Breed characterization on the basis of DNA markers
7. Genetic markers for quantitative traits loci
8. Microsatellite Molecular Markers for biodiversity in Animals
9. Molecular Markers in cattle fertility and dairy production
10. Marker assisted selection for incorporation of desirable traits DNA markers with economic traits
11. Mapping of Human and Animal genomes-Human Genome Project,
12. Mapping of Animal genomes- Monkey, Pig and Mice

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UNIT IV: Development and Applications of Transgenic Animals

1. Vector mediated gene transfer: Retrovirus-Mediated Gene Transfer
2. DNA Microinjection: Pronuclear microinjection, Embryonic Stem Cell method
3. Gene Transfer into Gametes: Sperm Mediated gene transfer, Testis Mediated Gene transfer
4. Somatic Cell Nuclear Transfer
5. Gene silencing: Generation of knockout mice and knock-in technology.
6. Applications of Transgenic animals: Disease Models: OncoMouse, HBV transgenic mice
7. Transgenic livestock
8. Environmental Pollution- Enviropigs
9. Medicine milk- Transgenic cow Rosie
10. Humanized organs from pigs
11. Pharmaceutical animals
12. Biosteel: Transgenic silk production in goats
13. The risks of the application of transgenic animals

Reference Books:

1. Culture of Animal Cells, (3rd Edn) R Ian Fredhney. Wiley - Liss
2. Animal Biotechnology- A.K. Srivastava, R.K. Singh, M.P. Yadav
3. Animal Cell Culture - Practical Approach, Ed. John RW. Masters, Oxford
4. Animal Biotechnology - Ashish S. Varma, Anchal Singh.
5. Animal Cell Culture Concept and Application - Sheelendra Mangal Bhatt



B. N. Singh
B.N.S.



BT303A - CANCER BIOLOGY

UNIT- 1 – Cancer cell biology

1. Common Causes of Cancer – Hereditary, Carcinogens Factors, Alcohol & Smoking
2. Properties and metabolics of Cancer cell
3. Cell Division methods, Proliferation, Immune system evasion
4. Types of cancers - Primary cancers,
5. Secondary cancers, sporadic cancers,
6. Hereditary cancers
7. Tumors – Benign – Uterine Fibroids,
8. Lipoma's. Malignant – Skin, Brain
9. Stages in cancer – The TNM system
10. Stages in cancer- The Number system

UNIT- 2 – Features of Cancer

1. Common symptoms of cancers – Colon Cancer, Leukemia,
2. Non-Hodgkin's Lymphoma
3. Alteration of cell signalling pathways - MAPK, RAS, NF-kB
4. Common Cancer Markers & Antigens - alpha-fetoprotein (AFP),
5. Cancer antigen 125 (CA125)
6. Cancer antigen 15-3 (CA15-3),
7. Carbohydrate antigen 19-9 (CA19-9),
8. Carcinoembryonic antigen (CEA),
9. Human chorionic gonadotropin (hCG or beta-hCG), prostate-specific antigen (PSA)
10. Diagnostic methods – Blood Chemistry Test (CBP), Cytogenetic analysis, Immunophenotyping

UNIT-3 – Treatment methods

1. General treatment methods for cancer treatment – Drug Therapy
 2. Radiation, Surgery
 3. Cancer immunotherapy - Lymphoma
 4. Melanoma, Prostrate– Examples
 5. Cancer Specific Gene Therapy – Glioblastoma – HSVtk , CART – cell therapy
 6. Melanoma - MDA-7, Pancreatic - TNF- α
 7. Vaccines - Whole cell vaccines
 8. Dendritic cell vaccines, Virus vaccines
 9. Prevention methods- Risk Lowering, Yoga, Meditation, Diet
 10. Post treatment methods – Diet, life style modification
- KAF*
BSM 07/11
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BT303B -NANOBIOTECHNOLOGY

UNIT I : Basics of Nanobiotechnology

1. Introduction and types of nanoparticles
2. Definition of a Nano system - Types of Nanocrystals-One Dimensional (1D)- Two Dimensional (2D) - Three Dimensional (3D) nanostructured materials –
3. Physical and chemical properties of nanoparticles
4. Conducting and semiconducting nanoparticles, quantum well, quantum dot, Quantum dot lasers, nanowires
5. Bionanomachines - ATP synthetase, Actin and myosin, Bacterial Flagella

UNIT II : Nanomedicine

1. Types of sensors - Electrochemical, Mechanical, Biological
2. Drug delivery systems- Dendrimers, drug-polymer conjugates; polymeric micelles; liposomes
3. Nanoparticles as carriers for genetic materials – DNA & RNA
4. Gold and Silver nanoparticles in drug targeting
5. Vaccines based on nanoparticles –
(A) virus-like particle, (B) liposome, (C) ISCOM (Immune stimulating complexes), (D) polymeric nanoparticle, (E) inorganic nanoparticle, (F) emulsion, and (G) exosome

UNIT III : Non-medical applications of Nano-biotechnology

1. Nano-fertilizers – Nano-NPK, ZnO-FeO
2. Nano-pesticides – Organic and inorganic nanopesticides
3. Bio-barcoding – Principle & Applications
4. Green plastics – Microbial & Plant based
5. Hydrogen fuel cells – Principle & Applications

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BT304 - GENOMICS & PROTEOMICS

UNIT I – STRUCTURAL GENOMICS

1. Organization and structure of genomes
2. Genome size, sequence complexity, Introns and Exons.
3. Genome structure in viruses and prokaryotes.
4. Bacterial genomic sequencing, assembly and annotation
5. De novo and reference based assembly

UNIT II – FUNCTIONAL GENOMICS

1. Chemical degradation method, Sanger's dideoxynucleotide synthetic method.
2. Direct DNA sequencing using PCR, Single molecule sequencing.
3. Sequencing by conventional shotgun method, Whole genome shotgun method.
4. Clone contig method.
5. Next generation sequencing.
6. Codon bias.
7. Exon trapping and CpG island.
8. SAGE – Serial Analysis of Gene Expression
9. DNA micro array gene expression profiling, global normalization of micro array data
10. RNAseq and NGS based whole transcriptome analysis. FPKM, Phred score.

UNIT III - PROTEOMICS

1. The Proteome, Mining proteomes
2. Bridging Genomics and Proteomics, Proteomics and the new biology.
3. Isoelectric focusing (IEF)
4. 2D Gel Electrophoresis
5. 2D - DIGE- Differential Gel Electrophoresis
6. iTRAQ, SILAC based proteomic analysis
7. Trypsin digestion and MS/MS analysis and peptide mass finger printing, MASCOT
8. Peptide mapping, N & C terminal sequencing

Books suggested:

1. Ajoy Paul. (2011). Text Book of Genetics- from Genes to Genomes, 3rd Edition, Books and Allied (P) Ltd, Kolkata.
2. Keith Wilson and John Walker. (2010). Principles and techniques of practical biochemistry, 7th Edition, Cambridge University Press.
3. Sathayanarayana U. (2008). Biotechnology, Books and Allied (P) Ltd., India.
4. Hubert Rehn. (2006). Protein Biochemistry and Proteomics, Academic Press.
5. Liebler Humana. (2002). Introduction to proteomics: Tools for new Biology, W.CBS Pub.,
6. Apweiler R. (2000). Protein sequence databases, Adv. Protein Chem. 54: 31-71.
7. Pearson WR. (1996). Effective protein sequence comparison, Methods Enzymol., 266: 227-258.
8. Spang R and Vingron M. (1998). Statistics of large scale sequence searching. Bioinformatics. 14: 279-284.
9. Baker D and Sali A. (2001). Protein structure prediction and structural genomics, Science, 294: 93-96.

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UNIT I : Intellectual property rights and Bioethics

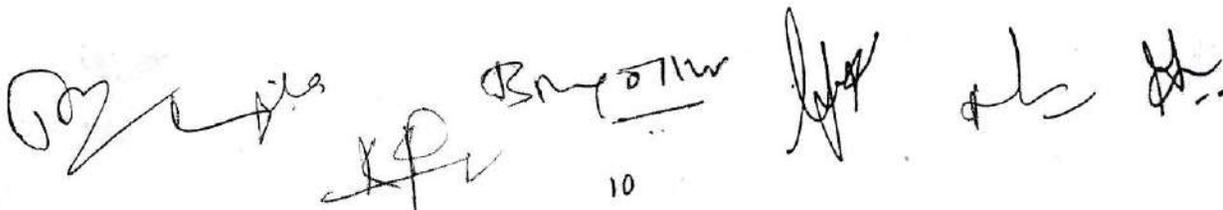
1. IPR Classification and forms
2. Patents, Trademarks, Copyrights, Industrial Design, Geographical Indications, Trade secrets
NBA- National Biodiversity Authority
3. Traditional Knowledge (Case studies: Haldi, Neem, Basamti Rice).
4. Procedure of obtaining patents in India, rights of patents
5. Infringement of patent rights, remedies for infringement of patent rights
6. Introduction and History of GATT, WTO & TRIPS, WIPO
7. Patent databases; Searching International Patent Databases
8. Country-wise patent searches (USPTO, EPO, IPO WIPO)
9. Patentability of biotechnological inventions
10. Protection of Plant varieties and Farmers rights Act
11. Patenting issues related to biosimilars
12. Bioethics: Role of bioethics in research, prevention and management of plagiarism, fabrication/manipulation of data, Belmont report.
13. Ethical implications of biotechnological products and techniques

UNIT II: Quality Management

1. Basic standards and need of standards
2. Biological standards - Microbial cell lines and standards.
3. Quality systems
4. Types of quality systems. ISI, ISO,
5. HACCP, USFDA 21 CFR,
6. Inspection and testing by DCGI
7. Handling, Storage, Packaging, Preservation of the material
8. Internal quality audits
9. Quality assurance: Indian (NABL) & International systems
10. Good laboratory practices
11. GLPs associated with drug, gene and cell based products
12. Good manufacturing practices
13. cGMP associated with drug, gene and cell-based products

UNIT III: Biosafety

1. Biosafety in the laboratory/institution: Laboratory associated infections and other hazards
2. Assessment of biological hazards and levels of biosafety
3. Prudent biosafety practices in the laboratory/ institution.
4. Biosafety Levels: Biosafety levels of specific microorganisms
5. Recommended biosafety levels for infectious agents and infected animals.
6. Biosafety guidelines: Government of India
7. Definition of GMOs & LMOs,
8. Roles of institutional biosafety committee, RCGM, GEAC
9. GMO applications in food and agriculture
10. Environmental release of GMOs Risk Analysis
11. Risk Assessment Risk management and communication
12. Biosafety assessment of biotech pharmaceutical products such as drugs / Vaccines etc.
13. Overview of National Regulations and relevant International Agreements including Cartagena Protocol



PRACTICALS

BT 305 P: PLANT & ANIMAL BIOTECHNOLOGY

Plant Biotechnology

1. Introduction to plant tissue culture, sterilization, lab practices and equipments.
2. Surface sterilization of explants, inoculation and induction of callus from the explants
3. Protoplast isolation and fusion
4. Induction of somatic embryogenesis & preparation of synthetic seeds
5. Micropropagation of an elite agricultural/horticultural plant species
6. Induction of hairy root cultures using *Agrobacterium rhizogenes*
7. Genetic transformation of desired plant tissue using *Agrobacterium tumefaciens*
8. Confirmation of putative genetically transformed plants using PCR/Southern blotting.

Animal Biotechnology

9. To study laboratory rules, equipment and sterilization techniques
10. To perform the preparation of media for animal tissue culture.
11. To perform the surface sterilization for animal materials.
12. Study of the role of serum in animal cell culture.
13. To ensure the population of cells required for the culture by cell counting methods and its viability by vital staining methods.
14. To ensure the differentiation of live cells from dead cells by giemsa stain method.
15. Preparation of chicken embryo fibroblast culture (monolayer).
16. Trypsinization of monolayer and sub-culturing.

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BT 306 P: ADVANCED BIOTECHNOLOGY

1. HeLa cells cultivation and characterization
2. IHC markers for skin cancer
3. DNA markers in skin cancer
4. Chemical synthesis of Silver & ZnO Nanoparticles
5. Green synthesis of Silver & ZnO Nanoparticles
6. Preparation of an Urease Biosensor
7. Preparation of a simple drug polymer conjugate
8. Preparation of Nanofertilizers
9. Preparation of Nanopesticide.
10. PHB granules identification
11. Hydrogen production by Blue-green algae
12. Native Polyacrylamide Gel Electrophoresis
13. SDS - Polyacrylamide Gel Electrophoresis
14. Protein-protein interaction: immune-neutralization (Antigen-antibody precipitation).
15. Molecular marker analysis: Restriction Fragment Length Polymorphism

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ID PAPER: Concepts and Applications of Biotechnology

I. Concepts of Biotechnology

1. Cell is a basic unit of living organisms
2. Ultra structure of Prokaryotic Cell and Eukaryotic Cell
3. History, Classification of Microorganisms
4. Immune system - Innate and Adaptive
5. Concepts of Chromosome and Gene
6. Genetic Material- DNA, RNA, Structure of DNA,
7. Replication of DNA
8. Transcription in prokaryotes
9. Translation mechanism
10. Chromosomal abnormalities and syndromes, Genetic counseling

II. Applications of Biotechnology

1. Enzymes useful in cloning: Restriction endonuclease, Polymerases, Ligases and Kinases
2. Cloning Vectors: Plasmids- pUC18
3. Principle of PCR, Real Time-PCR and Applications
4. Plant Tissue Culture-Media, Callus
5. Plant secondary metabolites and uses
6. Transgenic plants – Bt Cotton, Golden Rice
7. Animal Tissue Culture
8. Stem cell and application
9. Transgenic animals (Dolly, Molly)
10. Vaccines types and uses



M.Sc. BIOTECHNOLOGY
SEMESTER - IV
BT 401 T – BIOPROCESS AND FERMENTATION TECHNOLOGY

UNIT I: BASIC PRINCIPLES OF BIOPROCESS TECHNOLOGY

1. Introduction to concepts of bioprocess engineering.
2. Overview of bioprocess with their various components. Isolation, screening and maintenance of industrially important microbes.
3. Kinetic modeling, material balance and energy balance.
4. Strain improvement for increased yield and other desirable characteristics.
5. Microbial growth and death kinetics with respect to fermenters.
6. Optimization of bioprocess, yield coefficient, doubling time, specific productivity, growth rate, metabolic and biomass productivities.
7. Effect of temperature, pH and salt concentration and dissolved oxygen and pCO_2 on cell growth and product formation.

UNIT II: CONCEPTS OF BASIC MODES OF FERMENTATION PROCESSES AND BIOREACTOR DESIGNS

1. Types of fermenters.
2. Concepts of basic modes of fermentation - Batch, fed batch and perfusion batch and continuous; Solid substrate, surface and submerged fermentation.
3. Transport phenomenon in bioprocess system- Mass transfer, heat transfer and oxygen transfer.
4. Shear stress effects and energy inputs in bioreactor, fermentation media, sterilization of media and air
5. Design and types of culture/production vessels- Batch, Fed batch, single use bioreactors and wave bioreactors, CSTBR, airlift, packed bed and bubble column fermenter.
6. Impellers, baffles, spargers, vessel diameter and H/D ratio calculation, calculation of tip speed, power number calculation.
7. Classes of sensors, instrumentation and principles for measurement digital sensors and single use sensors, PAT tools, physical parameters in the fermenter

KPP
Dr. K. Prasad
Chairman
Board of Studies in Biotechnology
VIT-AP University
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UNIT III: UPSTREAM AND DOWNSTREAM PROCESSING

1. Media formulation, types of nutrients, limiting nutrient and their roles in cell growth and propagation.
2. Inoculum development and sterilization
3. Aeration and agitation in bioprocess
4. Measurement and control of bioprocess parameters
5. Scale up and scale down process
6. Purification of products: bioseparation techniques, cell disruption methods; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultrafiltration, drying, crystallization, storage and packaging; Treatment of effluent and its disposal.

UNIT IV: APPLICATIONS OF MICROBES IN FOOD PROCESS OPERATIONS AND PRODUCTION OF FERMENTED FOODS AND BEVERAGES

1. Cheese, yoghurt and bread production
2. Enzymes- proteases, lipases, cellulases & pectinases food ingredients and additives prepared by fermentation and their purification
3. Fermentation as a method of preparing and preserving foods
4. Microbes and their use in pickling, producing colours and flavours
5. Alcoholic beverages and other products
6. Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products.

REFERENCE BOOKS:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition, Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991. Annexure 1/ Page 15 of 26
5. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
6. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.

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7. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.

8. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

9. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

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BT 402 T – FOOD BIOTECHNOLOGY

UNIT I: FUNDAMENTALS OF FOOD BIOTECHNOLOGY

1. Role and Impact of Biotechnology in food industry
2. Importance of microorganisms in food industry
3. Factors influencing microbial activity.
4. Crosslinking of proteins role of cross-linking enzymes in meat.
5. Protein structure, rheology and texturization.
6. Dietary and Nutrient Recommendations.
7. Enzymes in food and feed.
8. Physical and chemical factors affecting fermentation in food processing.
9. Tools to predict physico-chemical properties of industrial food and cultivation media.
10. Artificial meat and Carbon footprint of food.
11. Applications of Nanotechnology – biosensors to detect nutrients and contaminants.

UNIT II: PRACTICES IN FOOD BIOTECHNOLOGY

1. Metabolic engineering of bacteria for food ingredients; Cynobacteria, Lactic acid bacteria.
2. Production of amino acids – physiological and genetic approaches: leucine, glutamic acid.
3. Production of pectinases – utilization in food processing
4. Microbial technology of food flavour and colours (erythrosine) production.
5. Food applications of algae– microalgae for food production using Spirulina, *Chlorella*.
6. Enzymes for food applications: Protease, lipase, Phytase
7. Applications of transgenic plants in food production; Golden Rice, Bt Brinjal.
8. Engineering starch, alternative sweeteners, plant oils for food use.
9. Applications of transgenic animals in food production- Transgenic fish
10. Egg as bioreactor for production proteins

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UNIT III: APPLICATIONS OF FOOD BIOTECHNOLOGY

1. Food yeasts and derivatives – industrial processes.
2. Bread and related products – ingredients and formulations, production processes.
3. Dairy products – applications of genetic engineering- designer milk, genetically modified cheese.
4. Fermented meat products. Chorizo, Salami.
5. Fermented fish products : Nagari, Shidol shutki.
6. Fermented vegetable products – fermented soy products.
7. Production of fermented vitamins, microbial pigments.
8. Microbial enzymes -overview, production of amylases, polygalacturonase.
9. Microbial polysaccharides: an overview of Xanthan gum, bacterial cellulose and alginate.
10. Functional foods – probiotics, prebiotics, synbiotics.

UNIT IV: FOOD SAFETY AND QUALITY MANAGEMENT.

1. Principles of Food Safety and Food quality.
2. Quality Management Principles – Food safety testing.
3. Types of adulterants – tests to detect adulterants in foods.
4. Indian and International food Laws and Regulations.
5. Quality system Certification – FSSAI, ISO, BQS.
6. Safety rules for building, equipments and food labelling.
7. Food allergy, food intolerance, contaminants of processing, foods residue contaminants.
8. Production in Food Industry – Fruit and Vegetable Processing, drying, brewing of beverages
9. Testing and measuring food products in production process.
10. External factors of quality control – Nutritional information, manufacture details with correct labelling
11. Regulatory, ethical, legal and social aspects of food biotechnology.

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REFERENCE BOOKS:

1. Swaminathan M.S. Dr. Hand Book of Food and Nutrition
2. Sumati R. Mudambi and M. V, Rajgopal. Fundamentals of Food and Nutrition
3. Nutrient Requirements and Recommended Dietary Allowances for Indians. National Institute of Nutrition, Indian Council of Medical Research, 2010
4. Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport
5. Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. Pergamon Press, New York.
6. Rosenthal, I. 1991. Milk and Milk Products. VCH, New York
7. Warner, J. M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi
8. Krammer, A. and Twigg, B.A. 1970. Quality Control for the Food Industry. 3rd Edn. AVI, Westport
9. Pattee, H.E. Ed. 1985. Evaluation of Quality of Fruits and Vegetables. AVI, Westport
10. Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. Tata Mc Graw Hill, New Delhi
11. Joshi, V.K. and Pandey, A. Ed. 1999. Biotechnology. Food Fermentation, (2 Vol. set). Education Publ. New Delhi
12. Knorr, D. 1982. Food Biotechnology. Marcel Dekker, New York
13. Inteat All: Food Quality Assurance: Principles and practices, CRC Press LLC
14. Knechtes P.L.: Food Safety: Theory and Practice, Jones and Bartlett Learning, USA
15. R.A Garg: The Food Safety and Standard Act, 2006 along with Rules and regulation, (2011) Commercial Law Publisher (India) Pvt. Ltd
16. Food Biotechnology by Mason Sutton & Skylar Barr, published by Ed-Tech Press 2018
17. Enzymes in Food Biotechnology: Production, Applications, and Future Prospects edited by Mohammed Kuddus, published by Academic Press 2018.
18. Functional Foods and Biotechnology: Biotransformation and Analysis of Functional Foods and Ingredients edited by Kalidas Shetty, Dipayan Sarkar, published by CRC Press 2020.
19. Industrial Microbiology - Michel J Waites

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BT-403/A: ENVIRONMENTAL BIOTECHNOLOGY

UNIT I: BIOMASS TO BIOFUELS

1. Plant biomass (Lignocellulose, starch, pectin, gum materials)
2. Animal biomass (chitin, milk whey, Slaughter house wastes)
3. Microbial biomass (algal blooms -in fresh and sea waters)
4. Microorganisms in lignocellulose degradation-Cellulases and xylanases
5. Biodegradation of starch, glycogen, pullulan, dextrans, Chitins, proteins.
6. Feed stocks: First Generation (corn, wheat, sugar beet sugar cane)
7. Second Generation (Miscanthus, switchgrass, poplar, willo)
8. Third Generation (Microalgae)
9. Biomass feed stock to fermentations.
10. Microbial production of biofuels: Bioethanol , Biodiesel, Biomethanation, Biohydrogen and Microbial Fuel cells
11. Pros and Cons of Biofuels

UNIT II: BIOCONVERSION AND BIOREMEDIATION

1. Types and sources of pollution - Inorganic, organic and biotic.
2. Environmental impact of pollution and measurement methods (EIA)
3. Waste water treatment - sewage treatment, common industrial effluent treatment and solid waste management
4. Concepts of bioremediation- biostimulation, bioaugmentation
5. *In-situ* bioremediation and *Ex-situ* bioremediation
6. Microbial bioremediation of oil spills and textiles effluents
7. Bioremediation of toxic metal ions – biosorption and bioaccumulation principles.
8. Microbial biotransformation of pesticides and xenobiotics (Microbial degradation of plastics).
9. Microbial leaching of ores – direct and indirect mechanisms
10. Concepts of phytoremediation - phytoaccumulation, phytovolatilization, rhizofiltration and phytostabilization

UNIT III: BIOFERTILIZERS , BIOPESTICIDES AND GMOs

1. Biofertilizers and their importance in crop productivity.
2. Factors affecting the efficacy of biofertilizers
3. Algal and fungal (mycorrhizae) biofertilizers.
4. Bacterial biofertilizers (rhizobial, free living N₂ fixers and phosphate solubilizing bacteria), their significance and practice.

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5. Biopesticides: Bacterial (Bt pesticides), fungal (*Trichoderma*).
6. Viral biopesticides – Baculovirus, NPV insecticides.
7. Production of biofertilizers and biopesticides for large scale application.
8. Microbial Biosurfactants and their application in Environment
9. Potential application of genetically modified organisms in Environment sector
10. Potential application of genetically modified organisms in Agriculture sector
11. Risks and controversies surrounding the use of GMOs

REFERENCE BOOKS:

1. Environmental biotechnology: theory and application John Wiley & Sons, Ltd. West Sussex, UK
2. M. Moo-Young, W.A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
3. M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India,
4. Stanley E. Manahan, 2009. Environmental Chemistry, Ninth Edition, CRC Press.
5. Environmental chemistry 5th edition by A.K.De. 1997.
6. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand & Co, New Delhi.
7. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
8. Kannaiyan, S. (2003). Biotechnology of Biofertilizers, CHIPS, Texas.
9. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New Delhi
10. Bruce E. Rittmann and Perry L. McCarty. 2001. Environmental Biotechnology :Principles and applications. McGraw Hill, Newyork.
11. Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.
12. Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.

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BT-403B: BIOENTREPRENEURSHIP

UNIT-I: FUNDAMENTALS OF BIO-ENTREPRENEURSHIP

1. Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation
2. Introduction to bio-business, qualities of entrepreneurs, Scope of bio-entrepreneurship, types of industries in the bio-entrepreneurship, types of industries in the bio-sector and their competitive dynamics, creating opportunities in bio industry.
3. Innovation and bio-entrepreneurship: Innovation as a strategy in Biotech Company's biotechnology based products and services. Innovation and translational research, risk factors and tools for strategic decision. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, startup, Make in India) patent landscape, IP protection and commercialization strategies.
4. Nature and importance of entrepreneurs, Govt. schemes for commercialization of technology (eg: Biotech Consortium India Limited)

UNIT-II: DEVELOPING A BUSINESS PLAN AND FINANCE MANAGEMENT

1. Business plan preparation (from lab to the market): Feasibility analysis by SWOT, socio-economic costs benefit analysis, sources of financial assistance, process of negotiation with financiers, government and regulatory authorities
2. Making a business proposal, pricing strategy , budget planning , statutory and legal requirements, financial management
3. basics in accounting practices, concepts of balance sheet, P&L account, and double entry bookkeeping.
4. Estimation of income, expenditure, profit, income tax etc., collaborations & partnership, information technology.

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UNIT-III: MARKETING STRATEGIES & TECHNOLOGY MANAGEMENT

1. Assessment of market demand for potential products of interest, Market Conditions and Segments, Market Research, Prediction of market changes: Identifying needs of customers including gaps in the market.
2. Packaging the product; Market Linkages, branding issues; developing distribution channels; Promotion Policies, Challenges in Marketing bio-products.
3. Technology Transfer agencies; regulations for transfer of foreign technologies, quality control, bioethics and biosafety issues-Understanding of regulatory compliances and procedures (CDSCO, NBA, GIP, GMP) - Managing Technology Transfer.

REFERENCE BOOKS:

1. Science Business: The promise , the reality, and the Future of Biotech , 1st Edition by Gary P. Pisan ISBN-13-978-1591398400; ISBN -10: 1591398401
2. From Alchemy to IPO: The Business of Biotechnology by Cynthia Robbins-roth ISBN-10:073820482x: ISBN-13-978-0738204826
3. Entrepreneurship for everyone : A Student textbook by Robert Mellor, Sage Publications Ltd.
4. Dynamics of Entrepreneurial development by Vasat Desai, Himalaya Publications
5. Marketing Mangment by Philip Kotler
6. Financial Accounting and Analysis by Khan and Jain.

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BT-404/A PHARMACEUTICAL BIOTECHNOLOGY

UNIT I: INTRODUCTION TO PHARMACOLOGY

1. Drugs- influencing factors
2. Drug concentration – response relationship
3. Receptor mechanisms of drug action and signal transduction mechanisms
4. Introduction to agonist, antagonist, competitive antagonist, partial antagonists
5. Therapeutic index, LD50, IC50, ED50
6. Drug toxicity and drug allergy

UNIT II: PRINCIPLES OF DRUG DESIGN AND DELIVERY

1. Denovo drug design techniques
2. Molecular modeling, molecular docking and pharmacophore optimization
3. Properties of drug likeliness, lipinski rule
4. *In-silico* calculation of ADMET parameters
5. Structural activity relationships in drug designing
6. Lead optimization and validation
7. Delivery of biopharmaceuticals – oral delivery systems, pulmonary delivery, nasal, transmucosal and transdermal delivery system.
8. Targeted approaches: Applications of Nano-biotechnology in drug development and delivery, Polymeric and metallic nanoparticles for drug delivery

UNIT III: BIOPHARMACEUTICS

1. General principles of pharmacokinetics
2. Pharmacodynamics parameters like absorption, distribution, metabolism and excretion and Toxicity
3. Factors affecting drug action and enzyme inhibitory studies
4. Phases of clinical trials
5. Personalized medicine
6. Pharmaceutically important biotechnological products and their actions

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REFERENCE BOOKS :

1. "Pharmaceutical Biotechnology" by S P Vyas
2. "Pharmaceutical Biotechnology" by V Sreenivasulu
3. "Health and Pharmaceutical Biotechnology" by K P Dinesh and D M Chetan
4. "Pharmaceutical Biotechnology Fundamenta" by Dr Chandraka Kokare
5. "Textbook of Pharmaceutical Biotechnology" by Kokate
6. "Pharmaceutical Biotechnology: Concepts and Applications" by Gary Walsh
7. "Pharmaceutical Biotechnology" by Gotam K Kukda Sunil D Purohit
8. Handbook of Pharmaceutical Biotechnology" by Jay P Rho and Stan G Louie

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BT 404/B VACCINE DESIGN AND DEVELOPMENT

UNIT I: VACCINE DESIGN

1. Historical background of vaccination, vaccine preventable infectious diseases.
2. Overview of the immune system and basic aspects of immune response(s) to vaccines.
3. Adjuvants: History, types, mechanisms and current achievements.
4. Structure-based Vaccine design - tools and techniques
5. Protein design, subunit vaccine component.
6. Immunization strategies for disease control and eradication.
7. Over view of bacterial and viral vaccines and their importance to public health.
8. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus and Pertussis.

UNIT II: VACCINE PRODUCTION

1. Production life cycle of inactivated bacterial vaccine: DTwP (Diphtheria, Tetanus, and whole cell pertussis), Adsorbed vaccines.
2. Antigens and epitopes – Types and methods of analysis- Affinity column purification, HPLC, Electrophoretic techniques.
3. Proteomic tools – Peptide mapping, Conventional and modern methodologies to bacterial seed strain characterization.
4. Cellular vaccines for cancers - Epitope based vaccines; Immunoinformatics and vaccine designing -TEPITOPE, EpiAssembler, EpiMatrics
5. DNA vaccines: vectors used in DNA vaccine production, plant based vaccines, edible vaccines
6. Synthetic vaccines – cloning strategies for vaccine production, peptide based vaccines, merits and demerits,

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UNIT III : VACCINE DELIVERY AND TESTING

1. Introduction to diagnostic reagents and role in testing
2. Features and types of Ag-Ab interactions,
3. Opacity determination, Identity test (slide/tube agglutination test, titre determination by tube agglutination test), Preservation, filling, physical checking, labelling and storage of Widal antigens.
4. Testing of toxoid (in vivo & in vitro), sterility testing.
5. Abnormal toxicity testing and potency testing.
6. Antigen display and delivery platforms - multivalent display, co-display, immunomodulation, genetic delivery.
7. New vaccines under development and prominent vaccine delivery systems. Diseases and their available vaccines.
8. Optimization effects on vaccine efficacy and its delivery
9. R&D Environment, equipment, and Licensing for Vaccine development.
10. Requirements of a universal vaccine

REFERENCE BOOKS :

1. Proteins. Walker, John M. (Ed.).
2. Immunochemical Protocols. Margaret M. Manson, Springer.
3. Current protocols in molecular biology, Wiley Interscience.
4. Guidelines on Quality of Diagnostic Reagents for Health Laboratories.
5. Schedule M, Drugs and Cosmetics Act.

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PRACTICALS

BT 405 P: FERMENTATION & FOOD BIOTECHNOLOGY

BIOPROCESS AND FERMENTATION TECHNOLOGY

1. Quantitative description of bioprocess by estimating specific growth rate of target organism using kinetic models and determination of yield co-efficient
2. Development of laboratory scale bioreactors
3. Purification of unknown compounds by using column chromatography
4. Identification of unknown compounds by TLC
5. Production of organic acids - Citric acid production & estimation
6. Screening and Isolation of alcohol producing microbes
7. Production of alcohol (wine)- Alcohol production & estimation
8. Estimation of total Acidity in the Alcohol samples
9. Cell/tissue immobilization

FOOD BIOTECHNOLOGY

1. Qualitative and quantitative analysis of carbohydrates and proteins in food.
2. Preparation and evaluation of cheese or fermented product.
3. Determination of fat content in milk.
4. Estimation of vitamins- vitamin A, C and riboflavin.
5. Food adulteration detection methods.
6. Tests for pesticidal residues in food.
7. Determination of aflatoxin in food.
8. Enumeration and identification of microorganisms in probiotic foods.

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BT 406 P: ADVANCED BIOTECHNOLOGY-II

ENVIRONMENTAL BIOTECHNOLOGY

1. Isolation of cellulases and xylanases producing microbes
2. Isolation of Amylase producing microbes
3. Biodegradation of lipids and proteins
4. Isolation of microbial biofertilizers
5. Isolation of Chitinase producing microbes
6. Bioremediation of industrial effluents (dye degradation) by biological methods

PHARMACEUTICAL BIOTECHNOLOGY

1. Enzyme based inhibition activity IC₅₀ calculation
2. Antioxidant activity of superoxide dismutase (SOD) and catalase
3. Drug cytotoxicity using a cell line (MTT assay)
4. Analysis of biological specifications for drug content and estimation of the C_{max}, T_{max}, and Area Under the Curve (AUC)
5. *In-silico* calculation of drug likeliness of small molecules by using lipinski rule and ADMET parameters
6. *In-silico* optimization of pharmacophore
7. Anti-microbial plate assay
8. Anti-fungal plate assay

VACCINE DESIGN AND DEVELOPMENT

1. Morphological, biochemical and serological characterization of bacterial culture.
2. Inoculation of media containing bottles.
3. Harvesting of growth and inactivation of culture.
4. Identity test by slide agglutination and titre determination by tube agglutination method.


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