# 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-1 | 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#) |

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.

# BT101-CELL BIOLOGY AND GENETICS

## UNIT 1: CELL STRUCTURE AND FUNCTION

### 1.1 Cell Internal organization

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

### 1.2 Function of Organelles involved in Cell Energetics and Metabolism

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

### 1.3 Cell communication

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

### 1.4 Cell Surface Receptors and Signalling

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

## UNIT 2: CELL CYCLE AND CELL PROCESSES

### 2.1 Cell cycle

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

### 2.2 Cell division

a. Mechanics of Cell Division- An over view of M-Phase & Different stages of mitosis.
b. Cohesin and Condensin in chromosome segregation.
c. Microtubules in spindle assembly, Structure of kinetochore
d. Centrosomes and its functions and Sister Chromatid separation.
e. Cytokinesis actin & myosin in the generation of contractile ring.
f. 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 assortments - 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 edtnMcGrawhill
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

# BT102. BIOCHEMISTRY & METABOLIC REGULATION

## UNIT 1: BIOMOLECULES AND METABOLISM

### 1.1 Biomolecules & Chemical Basis of life

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

### 1.2 Glycoconjugates

a. Proteoglycans, Glycoproteins, Glycolipids
b. Blood group substances,
c. Bacterial cell wall polysaccharides

### 1.3 Metabolism of Carbohydrates

a. Glycolysis & Kreb's cycle - Regulation
b. Gluconeogenesis, Glycogenolysis
c. Pentose phosphate pathway, Entner–Doudoroff pathway (ED Pathway), Cori cycle

### 1.4 Photosynthesis

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

## UNIT 2: AMINO ACIDS, PROTEINS & ENZYMES

### 2.1 Amino acids

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

### 2.2 Proteins

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

### 2.3 Protein - Structural and Functional Relationships

a. Stabilization of proteins, Protein crystallization
b. Protein degradation and introduction to molecular pathways controlling protein degradation,
c. Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.;
d. 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.
e. 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, LubertStryer)
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

**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
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,

## BT104. BIOANALYTICAL TECHNIQUES & BIOSTATISTICS

### Unit 1: BIOSTATISTICS

**1. Introduction to Biostatistics**

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

**1.2. Probability**

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

**1.3. Tests of Hypothesis**

a. Null and alternate hypothesis, test of significance, p-value
b. Test statistics: Z test (for proportions and means), t-test (students t-test, paired t test)
c. 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**

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

### Unit 2: BIO-ANALYTICAL TECHNIQUES

**2.1 Spectroscopy I Techniques**

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

**2.2 Spectroscopy II Techniques**

a. NMR & MRI – Types & applications
b. Mass spectra & its applications
c. ESR & PET, applications

**2.3 Spectrometric Techniques**

a. MALDI- TOF
b. Flow cytometry
c. 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.

# BT 201.MOLECULAR BIOLOGY & METAGENOMICS

## 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, hetrologous 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: METAGENOMICSSTUDIES 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 efficientmetagenomic 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.
3. Steitz& A.M. Weiner, Benjamin Cummings Publ. California
4. 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, OxfordUniv. 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: CONSTRUCTIONOF GENOMIC, CDNALIBRARIES AND TECHNIQUES EMPLOYED

**3.1 Gene cloning strategies**

a. DNA cloning methods

**3.2 Construction of Genomic and cDNALibraries**

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 SequencingMethods**

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. Myleiod 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 IIMMUNOGLOBULINS

### 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 AntibodiesProduction & 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)

c. Vaccines-Types of vaccines & Adjuvants

**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. Reever& I. Todd, Publ: Blackwell
3. Immuno diagnostics– By S.C. Rastogi, Publ: New Age
4. Immunology: By Richard A. Golds, Thomas J Kindt, Barbaraa 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

## 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

**1.4Specialized 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**

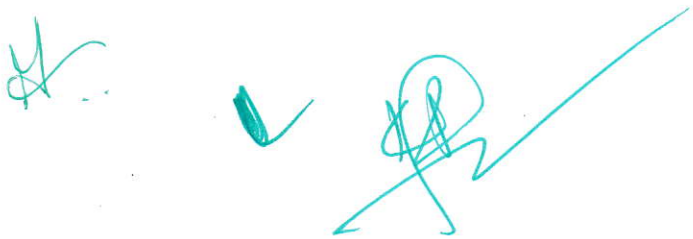
a. Microarrays
b. Disease profiling
c. Applications

**BT 206P-P2:BIOINFORMATICS & COMPUTATIONAL BIOLOGYPRACTICALS**

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. Baxevanis, 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)

**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

# 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

**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

# 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

## 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, quantam well, quantam dot, Quantam 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

## 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 shot gun 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, Acadamic 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. Bioinofrmatics. 14: 279-284.
9. Baker D and Sali A. (2001). Protein structure prediction and structural genomics, Science, 294: 93-96.

## BT304B - IPR, QUALITY MANAGEMENT, BIOSAFETY

### 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.

## 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 Nanofertiizers
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

## 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