University College of Science, Mahatma Gandhi University, Nalgonda
M.Sc Biotechnology (2 Yr PG Course) CBCS Proposed scheme for 2023-24 A.Y

Sl. No	Subjects	Credits	Instruction Hrs/week	Evaluation		Total
				Internal/Assignment + seminar	External	
Semester-I						
1	BT101. Cell Biology and genetics	4	4	20 +5+5	70	100
2	BT102. Biological Chemistry & Metabolic Regulation	4	4	20 +5+5	70	100
3	BT103. Microbiology	4	4	20 +5+5	70	100
4	BT104. Bioanalytical Techniques & Biostatistics	4	4	20 +5+5	70	100
5	BT105P. (P-1 &2)	3	6(+6*)	-	75	75
6	BT106P. (P-3 &4)	3	6(+6*)	-	75	75
	Total	22	28(+ 12*)	120	430	550
Semester-II						
1	BT201. Molecular Biology & Metagenomics	4	4	20 +5+5	70	100
2	BT202. rDNA technology	4	4	20 +5+5	70	100
3	BT203. Immunology	4	4	20 +5+5	70	100
4	BT204. Bioinformatics & Computational biology	4	4	20 +5+5	70	100
5	BT205P. (P-1 & 2)	3	6(+6*)	-	75	75
6	BT206P. (P-3 & 4)	3	6(+6*)	-	75	75
7	Open elective/ID-Concepts and Applications of Biotechnology	2	2	10+5	35	50
	Total	24	30(+ 12*)	135	465	600
Semester-III						
1	BT301. Plant Biotechnology	4	4	20 +5+5	70	100
2	BT302. Animal Biotechnology	4	4	20 +5+5	70	100
3	BT303/A. Medical Biotechnology BT303/B. Bio nanotechnology	3	3 (+ 3#)	15+5+5	50	75
4	BT304/A. Functional Genomics & Proteomics BT304/B. Cancer Biology	3	3 (+ 3#)	15+5+5	50	75
5	BT305P (P-1 & E-I (A/B))	3	6(+6*)	-	75	75
6	BT306P (P-2 & E-II(A/B))	3	6(+6*)	-	75	75
7	Open elective/ID	2	2	10+5	35	50
	Total	22	28(+6#)(+12*)	125	425	550
Semester-IV						
1	BT401.Bioprocess & Fermentation Technology	4	4	20 +5+5	70	100
2	BT402. Food Biotechnology	4	4	20 +5+5	70	100
3	BT403/A. Environmental Biotechnology BT403/B. Agricultural Biotechnology	3	3 (+ 3#)	15+5+5	50	75
4	BT404/A. Pharmaceutical Biotechnology BT404/B. 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	4		-	100	100
	Total	24	26(+12*)	110	490	600

	Sem-1	Sem-II	Sem-III	Sem-IV	Total
No of Crcdits	22	24	22	24	92
Marks	550	600	550	600	2300
Total Workload of Sem-I & III					$ 56 (+ 24*) (+ 6#)
Total Workload of Sem-II & IV					$ 56 (+ 24*) (+ 6#)

Note: $ Workload without ID paper and Project; * Batches are made for practical's if students more than 20; # if two optional (Electives) opted by different students; @ 1 hr./week workload for handling of project (individual/group).

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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

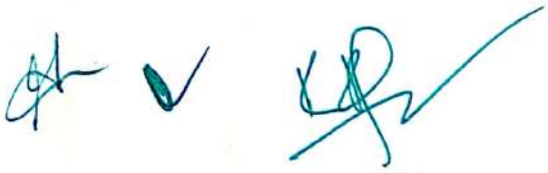
a. Structure and characteristics of plant viruses - TMV, CaMV, RTBV
b. Structure and characteristics of Hepatitis virus, Polio virus, HIV
c. Structure and characteristics of Corona and Influenza viruses

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

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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)

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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

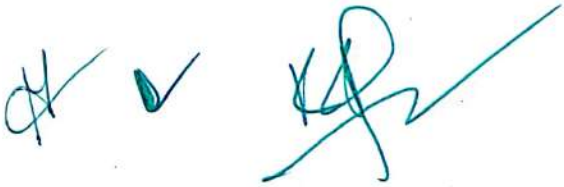
a. AUTODOCK
b. VINA
c. SWISS DOCK

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



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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