NIZAM COLLEGE (Autonomous)
Osmania University, Hyderabad 500001
B.Sc. I year Biotechnology CBCS Syllabus
Semester I
Paper I- Theory
FUNDAMENTALS OF BIOTECHNOLOGY- I

UNIT I:

1.1 Introduction to Biotechnology-History, Nature, Scope and future prospective
1.2 Cells as basic units of living organisms-Viruses, Bacteria, Fungi, Micro Algae, Plant and Animal cells
1.3 Ultra Structure of prokaryotic cell (Cell membrane, Plasmids)
1.4 Ultra structure of eukaryotic cell (Cell wall, Cell membrane, Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi complex)
1.5 Cell division and cell cycle
1.6 Significance of mitosis and meiosis

UNIT II:

2.1 Outlines of classification microorganisms – five kingdom classification
2.2 Growth requirements of bacteria, reproduction, growth curve, growth kinetics (Batch and Continuous)
2.3 Microbial techniques- media preparation, types of media (selective and differential media, enriched media, enrichment media. natural and synthetic media), sterilization, isolation of pure cultures, preservation of bacterial cultures
2.4 Genetics of bacteria and viruses**:** transformation, conjugation, transduction

UNIT III:

3.1 DNA as the genetic material – Griffiths experiments on transformation in Streptococcus pneumoniae. Avery, Mc Leod and Mc Carty's experiments
Hershey – Chase experiments with radio – labeled T2 bacteriophage
3.2 RNA as genetic material – Tobacco Mosaic Virus
3.3 Types of RNA – mRNA, tRNA, rRNA
3.4 Structure of DNA – Watson and Crick Model-
3.4 Forms of DNA– A, B and Z forms of DNA, Super coiled and related DNA-Role of Topoisomerases

UNIT IV:

4.1 Replication of DNA
4.2 Modes of replication of DNA- Conservative, Semi conservative and Dispersive: Messelson and stahl experiment.
4.3 Models of DNA replication -Circular and linear DNA; Bi directional replication (leading and lagging strand synthesis)
4.4 Enzymes involved in DNA replication
4.5 DNA damage and Repair mechanism.

REFERENCES:

1. Molecular Cell Biology, Lodish*et al.*,
2. Molecular Biology of the cell- Bruce Alberts,
3. Genes IX - Benjamin Lewin
4. Cell and Molecular biology – S.C.Rastogi
5. Cell Biology – Satyesh Chandra Roy, Kalyan Kumar De
6. Cell Biology – Karp
7. Cell Biology – C.B.Powar
8. Cell Biology,Genetics, MolecularBiology, Evolution & Ecology-P.S.Verma
9. General Microbiology –R. Y. StanierVIth edition.
10. Microbiology –Pelczar
11. Microbiology by Prescott
12. Text book of Microbiology by Tortora
13. Microbiology by Brock
14. A Textbook of Microbiology – P.Chakraborthy
15. Textbook of Microbiology by Ananthanarayan

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Semester II
Paper II- Theory

FUNDAMENTALS OF BIOTECHNOLOGY- II

UNIT I:

1.1 Mendel's experiments – factors contributing to Mendel's experiments
1.2 Genotype, Phenotype, Dominance, Recessiveness, Homozygote, Heterozygote
1.3 Test cross, Back cross and Reciprocal crosses
1.4 Law of segregation – Monohybrid ratio
1.5 Law of Independent assortment- Dihybrid, Trihybrids
1.6 Deviation from Mendel Laws – partial or incomplete dominance, co-dominance, Over dominance
1.7 Epistatic gene interaction- Modified dihybrid ratios (12:3:1, 9:7, 15:1, 9:3:4, 9:6:1, 13:3)
1.8 Characteristics of polygenes, examples: skin colour in humans
1.9 Penetrance and expressivity, pleiotropism, lethals and sublethals
1.10 Multiple alleles- ABO blood groups, coat color in Rabbit, Pseudo alleles- Rh factor
1.11 Genes and environment – Phenocopies
1.12 Pedigree analysis
1.13Maternal inheritance – Chloroplasts (ex:variegation in four O clock plants),
Mitochondria(ex: LHON)

UNIT II:

2.1 Linkage, crossing over and recombination-Discovery of linkage, cytological proof of crossing over
2.2 Recombination frequency and map distance, Two-point test cross and Three-point test cross
2.3 Interference& coincidence
2.4 Mitotic crossing over in Drosophila
2.5 Mechanism of sex determination- Genic balance theory- Drosophila
2.6 Dosage compensation – Barr bodies
2.7 Homogametic and hetero gametic theory (Human, Mammals, Birds and Plants)
2.8 Hormonal and environmental control of sex determination- Bonellia, reptiles
2.9 Sex linked inheritance- X- linkage, sex limited and sex influenced characters
2.10 Y- linkage – Holandric genes

UNIT III:

3.1 Measures of central values
3.2 Measures of dispersion. Skewness and Curtosis
3.3 Probability: definition, theorems of probability, application to Mendelian segregation
3.4 Concepts of probability distributions. Binomial and poison distributions, Normal distribution and their application to biology
3.5 Concepts of sampling and sampling distribution.
3.6 Statistical inference: test of significance – null and alternative hypothesis, critical region, type I and type II errors, level of significance.
3.7 Hypothesis testing: One sample inference – chi-square test;
Two sample inference – paired t test

Multiple sample inference - one way ANOVA

3.8 Simple regression and Correlation.

UNIT IV:

4.1 Biological databases–introduction to databases - sequence and structure databases, specialized databases

4.2 Major bioinformatics resources –NCBI, EBI, ExPASy

4.3 Sequence analysis and phylogeny: sequence alignment; introduction to scoring matrices PAM and BLOSSUM; similarity and database searching tools – FASTA, BLAST; introduction to phylogenetic trees.

4.4 Drug discovery– ligand designing and optimization, docking, applications in drug discovery.

REFERENCES:

1. Genetics by C.B.Powar
2. Genetics, Third edition by Monroe W. Strickberger
3. Principles of Genetics by Gardner, Simmons and Snustad
4. Genetics by Wintergreen.
5. Cell Biology,Genetics, MolecularBiology, Evolution & Ecology by P.S.Verma
6. Fundamentals of Biostatistics by khan and khanum
7. Biostatistics and Research Methodology by R.M.Ganbawale
8. Basics of Bioinformatics by Narayan Dubey
9. Principles of Biological Databases by Prof. P.B.Kavi Kishore, Mr.L.N.Chavali

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Semester III
Paper III- Theory

BIOLOGICAL CHEMISTRY

UNIT I:

1.1 Carbohydrates – general structure and properties of carbohydrates and their functions in the cell; sterioisomerism and mutarotation

- Monosaccharides (glucose, fructose, mannose, galactose),
- Dissacharides (sucrose, lactose, maltose, cellobiose)
- Homo and Hetero polysaccharides (starch, inulin, cellulose, chitin, hyaluronic acid)

1.2 Amino acids & Proteins:

- Aminoacids - Classification and structure of amino acids. Properties of aminoacids (zwitter ion, sterioisomerism)
- Primary, secondary, tertiary, quaternary levels of protein structure: types of bonds and forces that stabilize each level– alpha helix and beta sheets;

1.3 Lipids – general structure and properties of lipids and phospholipids and their function in the cell.

- Fatty acids – classification, structure and properties of saturated and unsaturated fatty acids; saponifiable and non saponifiable lipids
- Structure and functions of phospholipids (esp. lecithin cephalin, phospotidyl inositol and phospotidyl serine) spingo myelin. Structure and functions of cholesterol.

1.4 Vitamins and coenzymes: classification of vitamins- fat soluble and water soluble vitamins Biological role and importance of vitamins and their deficiencies.

UNIT II:

2.1 Enzymes: classification and nomenclature of enzymes;
2.2 Kinetics and Mechanism of enzyme action:

- Specificity of enzyme action
- Kinetics of single substrate reactions ,Michaelis –Menten's equation

2.3 Regulation of enzyme activity**:**

- Allosteric regulation of enzymes
- Factors influencing enzymatic reactions- ph, temperature, substrate conc, enzyme concentration

2.4 Enzyme inhibitions**:**competitive, non-competitive & uncompetitive inhibitions;

UNIT III:

3.1 Bioenergetics– catabolism and anabolism
3.2 Energy generating pathways – Glycolysis, TCA, ETC(chemiosmatic theory of ATP synthesis)
3.3 Photosynthesis**:**light reaction, dark reaction (calvin/C_3 cycle)

3.4 Carbon assimilation**:** C_4
3.5 Gluconeogenesis and its significance

UNIT IV:

4.1 Lipid metabolism**:** Degradation of fatty acids by β- oxidation(even and odd chain saturated fatty acids).
4.2 Protein Metabolism**:**transamination, deamination and decarboxylation of amino acids,
4.3 Catabolism of amino acids: phenylalanine and tyrosine(phenylketoneuria and albinism respectively)
4.4 HORMONES:

- Classification based on chemical nature(peptide, steroid hormones and amino acid derivatives)
- Hypothalamic and pituitary homones, thyroid hormones, adrenal hormones, Hormones of gonads, gastrointestinal hormones

REFERENCES:

1. Biochemistry by Lehninger
2. Principles of Biochemistry by Nelson and Cox
3. Biochemistry by Voet and Voet
4. Fundamentals of Biochemistry by A.C.Deb
5. Biochemistry by U.Satyanarayana

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Semester IV
Paper IV- Theory

BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

UNIT I:

1.1 P^H and Buffers.
1.2 Molecules and Interactions- Strong and Weak interactions in Biomolecules: Ionic, Covalent, Hydrogenbond, Vanderwaals forces.
1.3 Laws of Thermodynamics.
1.4 Microscopy- Principles and applications of Light and Electron microscopy - Dark field, Bright field, Phase contrast, Flouroscent Microscope, Scanning and Transmission Electron microscopy.
1.5 Spectroscopy- Principles and applications of UV and Visible Spectroscopy,
1.6 Colorimetry- Principles and applications of colorimetry, Beer-Lamberts Law.

UNIT II:

2.1 Chromatography- Principles and applications of Chromatography.
2.2 Types of Chromatography- paper, Thin Layer, IonExchange, Gel Filtration, Affinity Chromatography and HPLC.
2.3 Electrophoresis- Principle of Electrophoresis, support media, Agarose, polyacrylamide.
2.4 Types of Electrophoresis- SDS-PAGE, AGE (Agarose gel Electrophoresis), ImmunoElectrophoresis.

UNIT III:

3.1 Centrifugation- Principles and applications of Centrifugation.
3.2 Types of Centrifuges- Differential Centrifugation, Density Gradient Centrifugation (Rate zonal, isopycnic centrifugation), Ultra Centrifugation.
3.3 Radioactive isotopes and their types, measures of Radioactivity, GM Counter, Scintillation Counter.
3.4 Applications of Radio isotopes in medicine and diagnosis.

UNIT IV:

4.1 Autoradiography.
4.2 Dialysis.
4.3 Ultrafiltration.
4.4 Lyophilization.
4.5 Biosensors-principles and applications in Medical diagnosis, industrial, agriculture, Environmental monitoring.

REFERENCES:

1. Biophysical Chemistry- Principles and Techniques by Upadhyaya
2. Practical biochemistry principles and techniques by Wilson and Walker.
3. Instrumental methods of chemical analysis by Chatwal and Anand.

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Semester V
Paper V- Theory

MOLECULAR BIOLOGY

UNIT I:

3.1 ProkaryoticAndviralGenome organization
3.2 EukaryoticGenome organization:

- Chemical composition of DNA- GC content, C-Value and C- Value paradox
- Reassociation kinetics of DNA- Denaturation and renaturation,Melting temperature(Tm values), Cot curves
- Kinetic classes of DNA- Single copy sequences, repeated sequences, inverted,tandem and Palindromic repeats

3.3 Organellar Genomes:mitochondrial genome, chloroplast genome
3.4 Molecular organization of chromosomes:levels of chromosome organization in eukaryotes - chromatin, nucleosomes, 30nm fibre, looped domains, chromosome.

- Euchromatin and heterochromatin; centromers, teleomers;
- Specialised chromosomes – polytene and lampbrush chromosomes

3.5 Gene and gene numbers
3.6 Gene families and clusters- Globin, Ribosomal genes

UNIT II:

2.1 Exons, introns, promoters and terminators
2.2 Transcription – transcription in prokaryotes
2.3 Transcription in eukaryotes
2.4 Post-transcriptional modifications (Capping, polyadenylation, splicing and alternate Splicing)

UNIT III:

3.1 Translation: Genetic code and its features, single letter notation for amino acids, Wobble Hypothesis
3.2 Synthesis of polypeptides- initiation, elongation and termination in prokaryotes and Eukaryotes
3.3 Regulation of gene expression in prokaryotes-Lac operon
3.4 Regulation of gene expression in eukaryotes- Mating types in yeasts

REFERENCES:

1. Molecular Biology by David Frifelder
2. Genes IX by Benjamin Lewin
3. Molecular biology of the gene by J. D. Watson and et. al.,
4. Molecular Biology of the Cell by Bruce Alberts and et. al.,
5. Cell Biology,Genetics, MolecularBiology, Evolution & Ecology by P.S.Verma
6. Cell and Molecular biology by S.C.Rastogi

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Semester V
Paper VI - Theory
Elective - I

MEDICAL BIOTECHNOLOGY

UNIT I:

1.1 Classification of chromosomes- karyotype
1.2 Chromosomal disorders – Numerical disorders e.g. trisomies&monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes
1.3 Gain of function mutations: Huntington's disease
1.4 Loss of function -Tumor Suppressor Genes
1.5 Dynamic Mutations - Fragile- X syndrome
1.6 Mitochondrial diseases: MELAS, LHON, MERRF
1.7 Immuno Pathology, Hepatitis, HIV, Autoimmune Disorders-SLE, RA

UNIT II:

2.1 Clinical management and metabolic manipulation – PKU, Familial Hypercholesterolemia, ADA.
2.2 Gene therapy - Ex-vivo, Invivo, Insitu gene therapy; Strategies of gene therapy: Gene augmentation – ADA deficiency, CFTR
2.3 Vectors used in gene therapy - Biological vectors – retrovirus, adenoviruses, Synthetic vectors– liposomes, receptor mediated gene transfer
2.4 Stem cells- Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent

UNIT III:

3.1 Prenatal diagnosis - Invasive techniques - Amniocentesis, Chorionic Villi Sampling (CVS), Non-invasive techniques - Ultrasonography, TIFA,
3.2 Microarray technology- genomic and cDNA arrays, application to diseases
3.3 Gene products in medicine – Humulin,Erythropoietin, Growth Hormone (Somatostatin), tPA, Interferon γ
3.4 DNA based vaccines; Subunit vaccines – Herpes Simplex Virus; Attenuated Vaccines– Cholera; Vector vaccines – Cholera and Salmonella

REFERENCES:

1. Introduction to Human Molecular Genetics by J.J Pasternak.
2. Human Molecular Genetics by Tom Strachen and A P Read
3. Human Genetics Molecular Evolution byMcConkey,
4. Recombinant DNA Technology by AEH Emery
5. Principles and Practice of Medical Genetics by AEH Edts. Emery

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Paper VI- Theory
Elective-II

BIOPROCESS TECHNOLOGY

UNIT I:

1.1 Introduction to fermentation
1.2 Historical perspectives of fermentation technology and its applications
1.3 An overview of upstream and downstream processing
1.4 Design of fermenter- Components of fermenter and their functions
1.5 Types of Bioreactors- Stirred tank fermenter, Air lift fermenter, Bubble column fermenter Fluidised bed bioreactor, Packed bed bioreactor

UNIT II:

2.1 Media composition and formulation-Substrates used as Carbon and nitrogen sources
2.2 Bioprocess control
2.3 Instrumentation for controlling bioreactors
2.4 Online and offline analysis
2.5 Manual and automatic control systems
2.6 PID and DSC control computer systems

UNIT III:

3.1 Downstream processing - Foam separation
3.2 Primary separation – removal of insoluble products/cell (centrifugation, filtration and sedimentation)
3.3 Cell disruption (mechanical, enzymatic and chemical)
3.4 Product isolation –solvent extraction, adsorption, aqueous two-phase system and precipitation
3.5 Purification techniques
(a) Chromatography (ion exchange, gel permeation and affinity)
(b) Membrane separation (micro-filtration, ultra-filtration and reverse phase electrophoresis)
3.6 Product polishing (crystallization, drying and diafiltration)

REFERENCES:

1. Bioprocess Engineering: Basic Concepts byShuler,M.L. and Kargi, F.
2. Bioprocess Technology: Fundamentals and Applications by KTH, Stockholm
3. Principles of Fermentation technology byStanbury PF and Whitaker A.
4. Biotechnology: A text book of industrial Microbiology by Cruegar, W. and Cregar,
5. Bioprocess Engineering principles by Pauling M.Doran

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Semester VI
Paper VII - Theory

GENETIC ENGINEERING & IMMUNOLOGY

UNIT I:

1.1Enzymes used in gene cloning
a) Restriction endonucleases b) Polymerases c) Ligases d) Phosphatases e) Kinases f) Methylases
1.2 Properties of vectors cloning and expression vectors- Baculovirus vector system
1.3 Plasmids: Classification, basic features, size and copy number plasmid incompatibility, plasmid vectors (pBR322, pBR327, pUC)
1.4 Phage vectors: Insertional vectors (λgt), Replacement vectors (EMBL) m-13 vectors
1.5 Cosmids
1.6 Shuttle vectors

UNIT II:

2.1Construction of Genomic and c-DNA libraries, Cloning process – ligation and transformation
2.2 Selection of recombinant clones
a) Genetic selection b) Blotting techniques- Southern, Northern and Western
c) Hybrid released translation (HRT), Hybrid arrested translation (HART)
2.3 Principles and applications of PCR Technology, types of PCR (ARMS, RT, real time PCR)
2.4 DNA Finger printing technique and its applications
2.5 Applications of genetic engineering – Transgenic plants, Transgenic animals

UNIT III:

3.1 Immunity- Innate and Acquired immunity
3.2 Introduction to immune system – Organs and cells of the immune system
3.3 Antigens, Haptens: Physico-chemical characteristics
3.4 Structure of different immunoglobulins and their function Primary and secondary immune response
3.5 Antigen – antibody reaction
3.6 Monoclonal antibodies – Hybridoma techmology
3.7 The Major Histocompatiblity gene complex and its role in organ transplantation
Generation of antibody diversity
3.8 Hypersensitivity – Coombs classification, types of hypersensitivity
3.9 Autoimmune diseases – mechanism of autoimmunity

REFERENCES:

1. Molecular Biotechnology Principles & Applications of Recombinant DNA by Bernard R Glick & Jack J Pasternak.
2. Principles of Gene manipulations by Old R.W & Primrose.
3. Genomes 3 by T.A.Brown
4. Gene Biotechnology by S.N.Jogdand
5. Immunology by C.Vaman Rao
6. Immunology by Ivan Roitt,
7. Immunology by Fathima
8. Principles of Immunology by N.V.Shastri
9. Cellular and Molecular Immunology by Abul K Abbas, Andrew H.Litchman, Shiv Pillai

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Semester VI
Paper VIII- Theory
Elective – I

ANIMAL AND INDUSTRIAL BIOTECHNOLOGY

UNIT I:

1.1 Introduction and scope of animal biotechnology.
1.2 Animal cell culture- Culture vessels, growth media components and types of media- natural and artificial.
1.3 Primary cell culture techniques- Explant, Cell dissagregation(Mechanical, Enzymatic), Seperation of viable and non-viabie cells.
1.4 Establishment and Preservation of cell lines- Maintanence and types of cell lines- Finite and Continuous cell lines, preservation of Cell lines.
1.5 Methods of Gene transfer in Animal cells- Micro injection , Electroporation, Lipofection, Viral mediated gene transfer techniques.
1.6 Production of Transgenic Animals and Molecular Pharming.
1.7 Transgenic Animal Models for Studying diseases- Knock out, Alzeimers disease.

UNIT II:

2.1 Introduction and Scope of Industrial Biotechnology.
2.2 Primary and Secondary Metabolic products of micro organisms.
2.3Screening – Primary and secondary Screening Techniques, introduction to strain improvement.
2.4Types of fermentation- Classification of Fermentation based on availability of oxygen, media type(aerobic and anaerobic fermentation, solid state and submergedfermentation), Batch and Continuous Fermrntation.
2.5 Methods of immobilization- Adsorption, Covalent binding, Entrapment and Encapsulation methods.

UNIT III:

3.1 Production of Alcoholic Beverages - Wine, Alcohol/ Ethanol.
3.2 Production of chemicals - Citric acid, Glutamic acid.
3.3 Production of therapeutic proteins: Antibiotics- Penicillin, vitamins- Riboflavin.
3.4 Production of Enzymes- Amylases, Proteases.
3.5 Applications of immobilized Enzymes and Whole cells.

REFERENCES:

1. Animal Biotechnology by P. Ramadas.
2. Animal cell culture byFreshney.
3. Biotechnology by U.Satyanarayana
4. Animal Biotechnology by V.Kumaresan
5. Animal Biotechnology by M.M.Ranga
6. Microbial Biotechnology-Fundamentals of Applied Microbiology by Alexander N.Glazer, Hiroshi Nikaido
7. Industrial Biotechnology by L.E.Casida
8. Industrial Biotechnology by A.H.Patel.
9. Principles of Fermentation technology by P.F.Stanbury, and A.Whitakor

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Semester VI
Paper VIII- Theory
Elective – II

PLANT AND ENVIRONMENTAL BIOTECHNOLOGY

UNIT I:

1.1 Introduction and Scope of Plant Biotechnology
1.2 Cell totipotency and plant tissue culture
1.3 Composition of Media (MS Media, Gamborgs Media), Preparation of media and Sterilization Methods.
1.4 Role of Micronutrients and plant Growth regulators in Differentiation.
1.5 Types of Plant Tissue Culture - Callus culture, Cell suspension culture, Meritem culture, Embryo culture, Somatic embryogenesis (synthetic seeds) Protoplast culture.
1.6 Methods of Gene Transfer techniques in plants - Particle Bombardment, Micro injection, Electroporation, Agrobacterium mediated Gene Transfer, Lipofection.

UNIT 2:

2.1 Clonal propagation of plants on Commercial Scale (Micropropagation).
2.2 Somatic Hybridization.
2.3 Somaclonal Variation.
2.4 Anther culture (production of haploid plants)
2.5 Production of Secondary metabolites by Plant Cells (Shikonin)
2.6 Production of hairy roots.
2.7 Applications of recombinant DNA Technology in food (golden rice), Biotic and Abiotiuc stress tolerant plants .

UNIT III:

3.1 Introduction and scope of Environmental biotechnology.
3.2 Pollution – causes types of pollution.
3.3 Conventional, Non- Conventional energy sources and their impact on Enviroment.
3.4 Microbiological quality of Milk, food and Water.
3.5 Microbiological treatment of Municipal and industrial effluents.
3.6 Biofertilizers, Biopesticides, Bioremediation, Phytoremediation, Biomineralization, Biomonitoring and Biodeterioration.

REFERENCES:

1. Introduction to Plant Biotechnology by H.S.Chawla
2. Introduction to Plant Tissue Culture by M.K.Razdan
3. Biotechnology by U.Satyanarayana
4. Plant Molecular Biology by Grierson and S N Covey
5. Plant Biotechnology by S Ignacimuthu, S J Oxford and IBH
6. Plant Biotechnology: Recent Advances by P C Trivedi
7. Environmental Biotechnology by Foster C.F., John Ware D.A
8. Environmental Biotechnology by A.K. Chatterjee
9. Environmental Biotechnology by S.N.Jogdand.
10. Cell Biology, Immunology and Environmental Biology by Mohan P.Arora.