NIZAM COLLEGE (Autonomous)
Osmania University, Hyderabad 500001

B.Sc I year Biotechnology Syllabus
Semester I
Paper I- Theory

FUNDAMENTALS OF BIOTECHNOLOGY- I

Unit: I

1.1 Introduction to Biotechnology-History, Nature, Scope and future prospectives
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
2.2 Growth requirements of bacteria, reproduction, growth kinetics (Batch and Continuous)
2.3 Microbial techniques- media preparation, sterilization, isolation of pure cultures, preservation (Bacteria)
2.4 Disease causing pathogens and their symptoms (examples: Typhoid, HIV only)
2.5 Identification of Fungi and useful Micro Algae

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 Structure of DNA – Watson and Crick Model
Forms of DNA– A, B and Z forms of DNA, Super coiled and related DNA- Role of topoisomerases
3.4 DNA Replication – Models of DNA replication (Conservative, Semi conservative, Dispersive models)
Mechanism of DNA replication – Linear and Circular – Rolling circle and theta mechanism of replication
3.5 DNA damage and Repair

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B.Sc I year Biotechnology Syllabus
Semester II
Paper I- 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 Penetrance and expressivity, pleiotropism, lethals and sublethals
1.9 Multiple alleles- ABO blood groups, coat color in Rabbit, Pseudo alleles- Rh factor
1.10 Genes and environment – Phenocopies
1.11 Pedigree analysis

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 Homogametic and hetero gametic theory (Human, Mammals, Birds and Plants)
2.7 Environmental control of sex determination- Bonellia
2.8 Sex linked inheritance- X- linkage, sex limited and sex influenced characters
2.9 Y- linkage – Holandric genes

Unit: III

3.1 Measures of central values and dispersion. Graphical representation of data. Curtosis and skewness
3.2 Concepts of probability, basic laws and application to Mendelian segregation Concepts of probability distribution. Binomial and poison distributions, Normal distribution and their application to biology

3.3 Concepts of sampling and sampling distribution. Concept of test of hypothesis application of t- test statistics to biological problems/data: Chi-square statistic application in biology

3.4 Simple regression and Correlation. Concepts of analysis of variance (one- way Classification

3.5 Introduction to bioinformatics
Biological Databases – Nucleotide sequence and Protein databases,their utilization in Biotechnology, storage of biological data in databanks, data retrieval from databases and their utilization

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B.Sc II year Biotechnology Syllabus
Semester III
Paper III- Theory

BIOLOGICAL CHEMISTRY- I

Unit: I

1.1 **Carbohydrates:** Importance, classification and properties
1.2 Structure and configuration of monosacharides – (Haworth and Fischer projections) Glyceraldehyde, Dihydroxyacetone, Glucose, Mannose, Galactose Fructose
Stereoisomerism and mutarotation
1.3 Disaccharides – Maltose, Lactose, Cellobiose, Sucrose and Trehalose
Physiologically important glycosides (streptomycin, cardiac glycosides, ouabain)
1.4 Structure and function of homo polysaccharides- Starch, Glycogen, Inulin, Cellulose
1.5 Structure and function of hetero polysaccharides- Hyaluronic acid
1.6 **Lipids:**Fatty acids – saturated and unsaturated
1.7 Triacylglycerols, Phospholipids, Spingolipids, Sterols and Waxes
1.8 Saponifiable nonsaponifiable lipids

Unit: II

2.1 **Proteins**: Classification, structure and properties of amino acids
2.2. Sterioisomerism and allo forms of amino acids, Zwitter ion properties
2.3 Peptide bond – Synthesis and Character
2.4. Different levels of structure of proteins – primary, secondary, tertiary and quaternary
2.5 **Enzymes:** Classification and nomenclature of enzymes
2.6. Kinetics of enzyme catalyzed reactions
2.7 Factors influencing enzymatic reactions- $P^{H,\ Temperature}$, Substrate concentration, Enzyme concentration
2.8 Enzyme inhibition- Competitive and non-competitive

Unit: III

3.1 **Membrane Transport:** Passive transport- Simple and facilitated diffusion, Active transport
3.2 Carriers and ion channels (open and voltage gated)
3.3 Transport of ions-Uniport, Symport and Antiport
3.4. Na^+- K^+ pumps in animal cells
3.5 **Hormones:** Classification based on chemical nature and mechanism
3.5 Hypothalamic and pituitary homones, thyroid hormones, adrenal hormones, Hormones of gonads, gastrointestinal hormones

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B.Sc II year Biotechnology Syllabus
Semester IV
Paper IV- Theory

BIOLOGICAL CHEMISTRY- II

Unit: I

1.1 Bioenergetics
1.2 Metabolism (Catabolism and Anabolism)
1.3 Glycolysis
1.4 Citric acid cycle
1.5 Gluconeogenesis and its significance
1.6 Mitochondrial electron transport – Chemiosmotic theory of ATP synthesis

Unit: II

2.1 β- Oxidation of fatty acids
2.2 Deamination, decarboxylation and transamination reactions of amino acids
2.3 Catabolism of amino acid Phenylalanine and Tyrosine(Phenylketonuria and Albinism)
2.4 Photosynthesis- Light and Dark reactions, Photophosphorylation
2.5 Carbon Assimilation

Unit: III

3.1 Microscopy- Light, Inverted, Fluorescent and Electron microscopy
3.2 Colorimetry – Beer- Lambert's law
3.3 UV- VIS Spectrophotometry
3.4 Chromatography
(a) Paper (b) Thin Layer (c) Ion-exchange (d) Gel-filtration
3.5 Electrophoresis – native gels and SDS-PAGE, Agarose
3.6 Centrifugation and filtration- Basic Principles
3.7 Dialysis and lyophilization
3.8 Radio isotopes and their use in biology

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Bask III year Biotechnology Syllabus
Semester V
Paper V- Theory

MOLECULAR BIOLOGY

Unit: I

1.1 Chemical composition of DNA- GC content, C-Value and C- Value paradox
1.2. Reassociation kinetics of DNA- Denaturation and renaturation,
Melting temperature(T_m values), Cot curves
1.3. Kinetic classes of DNA- Single copy sequences, repeated sequences, inverted, tandem and Palindromic repeats
1.4. Eukaryotic chromosome morphology- Centromere and Telomere
Structure of specialized chromosomes (Polytene and Lamp Brush)
Euchromatin and heterochromatin
1.5. Classification of chromosomes- karyotype
1.6. Chromosomal aberrations- Structural and Numerical

Unit: II

2.1. Nuclear genome organization (Viruses, Prokaryotes, Eukaryotes)
2.2 Satellite DNA
2.3 Mitochondrial genome organization (Human)
2.4 Chloroplast genome organization (Plants)
2.5 Organization of eukaryotic genes- gene numbers- essential genes
2.6 Exons, introns, promoters and terminators
2.7 Gene families and clusters- Globin, Histone and Ribosomal genes

Unit: III

3.1 Transcription
Post-transcriptional modifications (Capping, polyadenylation, splicing and alternate Splicing)
3.2 Translation
Genetic code and its features, single letter notation for amino acids,
Wobble Hypothesis
Synthesis of polypeptides- initiation, elongation and termination in prokaryotes and Eukaryotes
3.3 Regulation gene expression in prokaryotes-Lac operon and eukaryotes
3.4 Mating types in yeasts

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Bask III year Biotechnology Syllabus
Semester V
Paper VI- Theory

GENETIC ENGINEERING

Unit: I

1.1 Enzymes 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 (p^{BR322}, p^{BR327}, pUC)
1.4 Phage vectors: Insertional vectors (λgt), Replacement vectors (EMBL)
m-13 vectors
1.5 Cosmids
1.6 Shuttle vectors

Unit: II

2.1 Construction of Genomic and c-DNA libraries
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
2.4 DNA Finger printing technique and its applications
2.5 Applications of genetic engineering (Insulin, Stomatostatin, Vaccines and
Golden rice)

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 The Major Histocompatiblity gene complex and its role in organ transplantation
Generation of antibody diversity
3.7 Hypersensitivity – Coombs classification, types of hypersensitivity
3.8 Autoimmune diseases – mechanism of autoimmunity

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Bask III year Biotechnology Syllabus
Semester VI
Paper VII- Theory

APPLICATIONS OF BIOTECHNOLOGY-I
(Animal and Industrial Biotechnology)

Unit: I

1.1 Introduction to animal biotechnology
1.2 Importance of live stock production – Inbreeding, Line breeding, Outbreeding and Cross breeding
1.3 Molecular markers and their use in breeding
1.4 In vitro- fertilization and embryo transfer, artificial insemination, multiple ovulation Fertilization of ova, in vitro culture of embryo, and embryo transfer
1.5 Cloning of animals

Unit: II

2.1 Methods of gene transfer- Microinjection, Electroporation, Liposome and Viral mediated gene transfer techniques
2.2 Production of transgenic animals and molecular pharming
2.3 Transgenic animal models for studying diseases
2.4 Principles of ex vivo and in vivo gene therapy
2.5 Principles of animal cell culture – culture vessels, media preparation, sterilization, Types of cultures, Explants and cell disaggregation
Establishment and preservation of cell lines
2.6 Culture of cells and tissues (Stem cells and their application
2.7 Animal cells as bioreactors- Production of human growth hormone, α and β interferons and monoclonal antibodies
Expression and over production of targeted proteins

Unit: III

3.1 Introduction to industrial biotechnology
3.2 Primary and secondary metabolic products of microorganisms
3.3 Screening, isolation and preservation of industrial microorganisms
3.4 Principles of fermentation technology
3.5 Commercial production of fuels and chemicals by microbial fermentations
3.6 Fermentative production of microbial enzymes (amylases and proteases) and antibiotics
3.7 Fermentative production of foods and dairy products
3.8 Good manufacturing practices, Biosafety issues, Bioethics
3.9 Intellectual property Rights and patenting issues

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Bask III year Biotechnology Syllabus
Semester VI
Paper VIII- Theory

APPLICATIONS OF BIOTECHNOLOGY-II
(Plant and Environmental Biotechnology)

Unit: I

1.1 Composition of media (Murashige and Skoog's and Gamborg's only) Preparation of media and methods of sterilizations
1.2 Role of micronutrients and plant growth regulators in differentiation
1.3 Induction of Callus
1.4 Meristem culture and production of virus free plants
1.5 Clonal propagation plants on a commercial scale(Somatic embryogenesis and Organogenesis)

Unit: II

2.1 Mass cultivation of cell cultures and process engineering- batch and continuous
2.2 Bioreactors
2.3 Production of useful compounds by plant cell cultures (Shikonin, alkaloids, food additives)
2.4 Biotransformation by plant cell cultures(Digitoxin,β-methyl digitoxin)
2.5 Production of therapeutic proteins from transgenic plants
2.6 Application of recombinant DNA technology in agriculture

Unit: III

3.1 Introduction to environmental biotechnology
3.2 Renewable and nonrenewable energy resources
3.3 Conventional energy sources and their impact on environment
3.4 Non-conventional fuels and their impact on environment(biogas, bioethanol, microbial hydrogen production)
3.5 Microbiological quality of milk, food and water'
3.6 Microbiological treatment of municipal and industrial effluents
3.7 Microbial degradation of pesticides and toxic chemicals
3.8 Biopesticides and biofertilizers(Nitrogen fixing, phosphate solubilizing microorganisms)
3.9 Microbial ore leaching
3.10 Introduction to Bioremediation

Practical Syllabus
Fundamentals of Biotechnology

Paper – I

1. Laboratory Instructions
2. Laboratory requirements
3. Sterilization- Autoclave, Hot Air Oven, Filtration and Radiation
4. Preparation of media- Nutrient Agar and Nutrient Broth
5. Isolation of Pure Cultures- Streak plate method, Spread plate method, Pour plate method
6. Simple Staining
7. Differential Staining – Gram's staining
8. Spore Staining
9. Identification of bacteria- E.coli, Pseudomonas, Bacillus and Staphylococcus
10. Microscopic observations of microorganisms
11. Observation of different stages of Mitosis and Meiosis
12. Estimation of DNA by diphenylamine method
13. Estimation of RNA by Orcinol method

Paper-II

1. Study of Drosophila
2. Monohybrid and dihybrid ratio in Drosophila/Maize
3. Problems on Monohybrid and Dihybrid crosses
4. Problem on gene interactions
5. Problems on linkage, crossing over and gene mapping
6. Measures of central tendency- Mean, Median, Mode, Geometric mean and Harmonic Mean
7. Measures of Dispersion- Mean deviation, Variance and Standard deviation
8. Test of significance
   X^2 test: Test of goodness of fit
   Fitting Binomial and Poisson distribution
   Test of Independence
   Test of Homogenity
   Test of Linkage
   t- test: Fitting statistical significance of a given data
9. Acquitance with the Biological databases through Internet

Practical Syllabus
Biological Chemistry

Paper- III

1. Qualitative tests of Sugars
2. Qualitative analysis of Sugars – Ribose, Glucose, Fructose, Maltose, Lactose, Sucrose and Starch
3. Qualitative tests of Amino acids
4. Qualitative analysis of Amino acids – Cysteine, Cystine, Methionine, Tyrosine, Tryptophan, Arginine and Proline
5. Qualitative analysis of Lipids- Stearic acid, Oleic acid, Glycerol and Triacyl glycerol
6. Quantitative estimation of sugars by Anthrone method
7. Quantitative estimation of proteins by Biuret method
8. Enzyme assay- (Amylase/ Catalase/ Invertase)

Paper- IV

1. Preparation of Normal, Molar and Molal solutions
2. Preparation of Buffers (Acidic, Neutral and Alkaline Buffers)
3. Separation of amino acids by paper chromatography
4. Separation of plant leaf pigments by paper chromatography
5. Separation of amino acids by thin layer chromatography
6. Separation of sugars by thin layer chromatography
7. Separation of plant leaf pigments by thin layer chromatography
8. Separation of plant leaf pigments on Alumina column
9. Separation of amino acids by paper electrophoresis
10. Electrophoresis separation of proteins (SDS-PAGE)
11. Techniques of Micrometry

Practical Syllabus
Molecular Biology and Genetic Engineering

Paper- V

1. Isolation of DNA from plant/animal/bacterial cells
2. Analysis of DNA by agars gel electrophoresis
3. Problems on Nucleic acids
4. Problems on Reassociation kinetics of DNA
5. Restriction mapping
6. Restriction digestion of DNA
7. Preparation of competent cells of Bacteria
8. Bacterial Transformation
9. Blood Grouping (Hemagglutination)
10. R.B.C Counting
11. W.B.C Counting
12. Differential staining of Leucocytes
13. Immunodiffusion test (RID/ODD)
14. ELISA Test
15. Comb's Test

Practical Syllabus
Application of Biotechnology

Paper- VI

1. Growth curves of bacteria, Measurements of growth in liquid cultures
2. Antibiotic sensitivity test
3. Screening for Organic acid producing microorganisms
4. Citric acid fermentation
5. Screening for Amylase producing microorganisms
6. Amylase production
7. Alcohol fermentation and calculation of fermentation efficiency
8. Wine production
9. Preparation of media and culture of animal cells/tissues
10. Cell disaggregation and cell counting
11. Cytotoxicity of the cells using the dye MTT method
12. Preparation of M.S media
13. Sterilization techniques employed in Plant Tissue Culture
14. Initiation of callus from any one selected plant species
15. Micropropagation of plants
16. Preparation of synthetic seeds
17. Estimation of alkalinity of water
18. Estimation of salinity of water
19. Estimation of dissolved oxygen in water
20. Estimation of BOD in water
21. Quality testing of milk by MBRT
22. Production of biogas using cow/cattle dung
23. Production of biofertilizers (Azolla)