

ANDHRA PRADESH
RECRUITMENT OF ASSISTANT PROFESSORS IN THE UNIVERSITY
SYLLABUS FOR THE SCREENING TEST

BIO TECHNOLOGY
SUBJECT CODE – 6

1. CELL BIOLOGY

Prokaryotic and eukaryotic cell structure; Morphology and functions of endoplasmic reticulum. Ribosomes- eukaryotic and prokaryotic. Ribosomal proteins. Role of Golgi in protein secretion. Lysosomes and peroxisomes. Cytoskeletal elements. Cell-cell interaction.

Mitochondria — structure, biogenesis and enzymatic compartmentation. Organization of mitochondrial respiratory chain, mechanism of oxidative phosphorylation. Ultra structure of the chloroplast. Photosynthesis- photophosphorylation. Carbon dioxide fixation in C-3, C-4 and CAM plants. Photorespiration.

Cell signalling and signal transduction; Post-translational modifications; Protein trafficking; Cell death and autophagy; Extra-cellular matrix. Cell cycle- Different stages, regulation, check points and Cdk-cyclin complexes and their in cell cycle.

Cancer- Stages, causes, properties of cancerous cells. Oncogenes, functions of oncogene products. Oncogene and signal transduction, G- proteins, Tumor suppressor genes. Diagnosis, prevention and treatment of cancer.

2. BIOMOLECULES

Chemical foundations of Biology — pH, pK, acids, bases, buffers, weak bonds and covalent bonds. Classification, Structure, properties and biological significance of carbohydrates. Biological role of peptidoglycans, glycosamino glycans and Lectins.

Lipids — Classification, Structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

Amino acids — Classification, structure and physico-chemical properties. Chemical synthesis of peptides —solid phase peptide synthesis.

Proteins classification, purification and criteria of homogeneity. Structural organization, sequence determination and characterization of proteins. Confirmation of proteins — Ramachandran plots. Denaturation of proteins. Hetero cyclic compounds _Heme and Chlorophylls.

Structure and properties of purines, pyrimidines, nucleosides, and nucleotides. Covalent structure of DNA and different forms of DNA — A,B and Z. DNA super coiling. Types of RNA and covalent structure of t-RNA. Classification, structure and physiological roles of Vitamins.

Hormones-classification and mechanism of action of steroid and protein hormones. Signal transduction cascade by cyclic AMP, Phospho inositide and calcium (Ca), G-proteins, growth factors and membrane receptor tyrosine kinases. Phytohormones and their physiological role.

3. MICROBIAL PHYSIOLOGY & GENETICS

Methods of sterilizations- Principles and methods, Physical, chemical and disinfection. Preparation of bacteriological media. Cultivation and preservation methods for bacteria. Identification of bacteria- Staining techniques. Differences between gram positive and gram negative bacteria. Bacterial reproduction and growth curve. Batch and continuous growth. Mathematical expression of growth. Clinically important bacteria. Antibiotics-mechanism of action, drug resistance in bacteria.

Chemical nature and classification of bacteriophages. Parasitic and temperate phages. Plant and animal viruses — multiplication of viruses. General characteristics of T Phage, ϕ x174, SV40, TMV. Clinically important viruses, retroviruses, HIV, Hepatitis B Virus and viral infections. General account of algae molds and yeasts. Clinically significant protozoans.

Microbial genetics: Recombination in prokaryotes, Transformation, conjugation, transduction and sexduction. Mapping of prokaryotic gene. Transposons, retrotransposons and mechanism of transposition. Biology of plasmids. Extra chromosomal inheritance.

Genetics of Eukaryotes: Gene & Environment, Genotype and phenotype, Mendel's experiments, Dominance relationships. Multiple alleles, Gene Interaction, Gene mutations, Sex determination, Sex linkage, Linkage and recombination in diploids. Tetrad analysis. Elements of gene mapping, Pedigree analysis.

4. ANALYTICAL TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

Principles and applications of light, phase contract, fluorescence, scanning and transmission electron microscopy. Properties of electromagnetic radiations. Principles, instrumentation and applications of U V, visible, NMR spectroscopy, mass spectrometry, X-ray diffraction. Flow cytometry.

Basic principles of sedimentation. Applications of preparative and analytical ultra centrifuges. Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC.

General principles of electrophoretic techniques. Agarose gel electrophoresis of DNA and RNA. Poly Acryl amide Gel Electrophoresis. Iso-electric focusing. 2-D Electrophoresis. Capillary electrophoresis. Blotting techniques.

Stable and radioactive isotopes. Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences. Autoradiography. Non-isotopic tracer techniques.

5. ENZYMOLOGY & METABOLISM

Classification and Nomenclature of Enzymes, Enzyme kinetics, Factors affecting the rates of enzyme catalysed reactions. Assay of enzyme activity-units of enzyme activity. Multisubstrate reactions. Enzyme- substrate (protein ligand) binding. Methods for measurement of k_m . Coenzymes, metalloenzymes, and isoenzymes with examples.

Active site determination. Mechanism of enzyme action of Chymotrypsin & Trypsin, carboxy peptidase — A and ribonuclease A. Multienzyme systems. Covalent modification. Zymogen activation. Enzyme inhibition Competitive, non-competitive and uncompetitive. Allosteric enzymes, Ribozymes and catalytic antibodies.

Glycolysis, Glycogenolysis, Glycogenesis, Gluconeogenesis, 11MP shunt path way and their regulation. Tricarboxylic acid (TCA) cycle, Glyoxylate cycle and its significance. Biosynthesis and oxidation of fatty acids. Metabolism of cholesterol. Ketone bodies. Biosynthesis of Heme and chlorophylls

General metabolic reactions of amino acids. Urea cycle. Nitrogen fixation. Essential and non-essential amino acids. Biosynthesis and degradation of aromatic and branched chain amino acids. Inborn errors of amino acid metabolism. Biosynthesis of purine and pyrimidinucleotides and their regulation. Catabolism of purines and pyrimidines.

6. MOLECULAR BIOLOGY

Organization of genetic material — Packing of DNA into chromatin — protein components of chromatin, histones, nucleosome organization. Solenoids loops, domains & scaffolds. Gene amplification, polyploid chromosomes. DNA replication apparatus, enzymes involved and mechanism. Replication at telomeres. DNA damage and repair mechanism. Nuclear genome. C — value paradox. Mitochondrial & plastid genomes and genes. Fine structure of the eukaryotic gene. Split genes. Different kinds of genes: overlapping, assembled, polyprotein & nested genes.

Transcription in prokaryotes and eukaryotes. Mechanism of transcription, enzymes and transcription factors, zinc finger, leucine zipper mechanism. Maturation and processing of m-RNA, splicing, 5' end capping & 3' end tailing, RNA editing and transport. RNAi and small RNAs.

Translation in prokaryotes and eukaryotes: Genetic code — properties of the genetic code, deciphering of the genetic code. Ribosome as a translation factory. t-RNA as an adaptor, its mode of function. Post translational modifications. Leader sequences & protein targeting.

Regulation of gene expression in prokaryotes — The operon concept, lac & trp operons. Transcriptional control. Post translation control. Regulation in eukaryotes — Control by promoter, enhancer and silencers. Cis-trans elements. Environmental & developmental regulation. DNA methylation & gene expression. Chromatin structure & gene expression.

7: GENETIC ENGINEERING

DNA cloning. Enzymes used in genetic engineering : Restriction endonucleases types, nomenclature and properties. DNA polymerase-I polynucleotide kinase, DNA ligase, terminal nucleotide transferase, Reverse transcriptase, alkaline phosphatase, S1 nuclease.

Salient features of cloning vectors, types of cloning vectors — plasmids, cosmids, phages (lambda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes — YACs and MACs, Preparation of gene libraries and c-DNA libraries.

Techniques of gene transfer — transformation, transfection, micro injection, electroporation, lipofection and biolistics. Selection of r-DNA clones and their expression.

Nucleic acid probes, DNA/RNA labelling, colony and fluorescent in-situ hybridization.

Polymerase Chain Reaction and its applications. DNA fingerprinting, RAPD, RFLP; Site-directed mutagenesis; DNA micro array technology. DNA sequencing by chemical and enzymatic methods. Genomics- genome sequencing by shot gun and hierarchical method. Genome annotation — identification of genes, promoters and exon — intron boundaries. Gene editing technologies-CRISPR-Cas, RNA interference, Si RNA.

8. BIOLOGY OF IMMUNE SYSTEM

Organisation and structure of lymphoid organs bone marrow, thymus, spleen and lymph nodes. Cells of the immune system — B - Lymphocytes, T — Lymphocytes. Types of cell mediated immunity and lymphokine activated killer cells. Adjuvants and immunological tolerance.

Nature of antigens and antibodies. Structure and function of antibodies. Isotypes, Allotypes and Idiotypes. Antigen — antibody interactions. The generation of antibody diversity, antigen receptors on B & T lymphocytes. Major Histocompatibility Complex (MHC). Human leukocyte antigens (HLA), MHC restriction and typing. Lymphokines. Complement system.

Immunological techniques — ELISA, RIA, Western Blot, Immunoblot and Immuno fluorescent techniques. FACS. Hybridoma technology — production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

Hypersensitivity — types of hypersensitivity — immediate and delayed hypersensitivity, autoimmune diseases, transplantation and immunity, immunity to infectious agents. Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology.

9: CELL CULTURE TECHNOLOGY AND TISSUE ENGINEERING

Plant tissue culture technology: culture media composition and preparation. Factors governing in vitro behavior, Somatic embryogenesis, organogenesis and plant regeneration. Culture types. Micro propagation, Haploids, somaclonal variations, metabolite production in cultures. Isolation of protoplasts, protoplast fusion and culture. Somatic hybridization.

Animal cell and tissue culture. Primary culture, balanced salt solutions and simple growth medium. Serum and protein free defined media. Cell lines, primary and established cell line cultures. Basic techniques of mammalian cell culture in vitro. Tissue and organ culture. Production and use of artificial tissues and organs —skin, liver and pancreas. Apoptosis —mechanism and significance.

The biology of stem cells — Different types of stem cells — embryonic stem cells, fetal tissue stem cells, adult stem cells; stem cell differentiation, stem cell plasticity — Differentiation versus stem cell renewal. Isolation and propagation of embryonic stem cells; chimeras; generation of knockout mice and knock-in technology.

Hematopoietic stem cells and bone marrow transplantation: Cells for hematopoietic reconstitution — Cord blood stem cells; cells for adoptive cellular immunotherapy; bone marrow transplantation — advantages and disadvantages. Allogenic, autologous, syngenic and congenic transplantation. Clinical applications of stem cell therapy; neurodegenerative diseases — Parkinson's disease, Alzheimers, spinal cord injury and other brain syndromes.

10 : PLANT & AGRICULTURE BIOTECHNOLOGY

Plant Genetic engineering: Gene cloning techniques, Direct gene transfer methods- Particle bombardment, electroporation, microinjection and protoplast fusion. Mechanism of gene transfer by TI and RI plasmids as vectors. Reporter genes, transient gene assays and identification of transgenic plants. Hairy root cultures. Molecular markers and their significance. RFLP, AFLP and QTL in plants. RAPD for molecular mapping and crop improvement.

Transgenesis and transgenic plants with an emphasis on Arabidopsis, tobacco, cotton and rice as model systems. Transgenic plants as Bioreactors. Biotic and abiotic stress tolerant plants. Herbicide resistance — glyphosphate, Insect resistance- Bt genes, non-Bt like protease & lectin inhibitors, Virus resistance-coat proteins mediated, nucleocapsid gene. Disease resistance- chitinase, 1-3 beta glucanase, PR Proteins.

Abiotic stress-Drought, cold & salinity.post- harvest losses, long shelf life of fruits male sterile lines- barstar & barnase system. Nutrition quality improvement. Transgenic approach for nitrogen fixation (nif & nod genes).

Plant secondary metabolites- concept and their importance. Factors (physical & chemical) that influence the production of secondary metabolites. Control mechanisms-phenylpropanoid pathway, shikimate pathway.

Algal Biotechnology: Marine micro algae/sea weeds and their products. Edible sea weeds and their cultivation. Bio fertilizers — Blue green algal fertilizers — Azolla, Anabaena, symbiotic association. Bio pesticides in agricultural production.

11 : ANIMAL BIOTECHNOLOGY

Types and causes of male and female infertility, sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation, oocyte maturation in vitro, In vitro fertilization in humans and cattle. Embryo culture, embryo transfer in farm animals. Immunocontraception hormonal methods. Biotechnological approaches for the management of pests, and nematodes.

Production of transgenic animals — mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans — Legal and ethical aspects. Potential applications of transgenic animals — Animal models for diseases and disorders. Applications of Biotechnology in animal health.

Aquaculture — Fresh and brakish water fish culture practices and types. Freshwater and brakish water prawn culture, shrimp and crab culture practices. Genetic status and manipulation of fish- Hypophysation and induced breeding techniques. Neuroendocrine principle of growth and reproduction in crustaceans. Molecular methods for diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens.

12: MEDICAL AND ENVIRONMENTAL

Health care products. Products from recombinant DNA Technology — insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines and Hepatitis - B vaccines.

Disease diagnosis: DNA probes, Enzyme probes — glucose oxidase, lactate oxidase, monoamine oxidase, PCR amplification and diagnosis- Applications in forensic medicine. Genetic diseases and gene therapy. Current strategies for development of vaccines against HIV, Malaria, Tuberculosis.

Environmental pollution — types, sources and control, Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Removal of oil spills. Environmental monitoring and bio monitoring. Bioremediation — solid and liquid waste treatment. Biomass and energy production from waste. Bioleaching. — Microbial recovery of metals and acid mine drainage. Water pollution and its control. Microbiology of waste water treatment.

Environment and energy: Renewable sources of energy — Biogas, waste materials, energy corps, cellulose. Production of energy and fuel using microorganism — Biofuels and Biodiesel. Global environmental problems: Ozone depletion, UV-B, Greenhouse effect, Biodiversity, benefits to mankind — Conservation. Ecology and sustainable development.

13: BIOPROCESS ENGINEERING AND ENZYME TECHNOLOGY

Principles of microbial growth: Batch fermentation, fed —batch fermentation — continuous fermentation; Bioreactors — Airlift reactors, Packed bed reactors, Stirred tank reactors, Photo bioreactors.

Upstream and Downstream Processing: Media formulation and optimization; Sterilization of air and media; Filtration - membrane filtration, ultrafiltration; Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extraction, adsorption and drying

Processing technology: Microbial metabolites — Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Wines and beers, Antibiotics (penicillin, streptomycin, tetracycline), Vitamins (Vitamin 1312 and Riboflavin), Amino acids (lysine, glutamic acid). Production of single cell proteins. Production of dairy and non-dairy products.

Heterologous Proteins: Production of active recombinant proteins of mammalian/Eukaryotic origin in prokaryotes. Large scale production of proteins from recombinant micro organisms.

Enzyme technology: Isolation and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes, application and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors — principle and types.

14: OMICS AND NANOBIOTECHNOLOGY

Introduction to Genomics, Structural organization of genome in Prokaryotes and Eukaryote, DNA sequencing- principles and translation to large scale projects; Tools for genome analysis, DNA fingerprinting technique. Human Genomic Project and its Important Applications.

Introduction to Proteomics. Protein sequencing; Protein modifications and proteomics; Applications of proteome analysis to drug; Protein engineering; Protein chips and functional proteomics; Clinical and biomedical application of proteomics; Proteome database.

Introduction to Nanobiotechnology: Types of Nanomaterials ; Strategies for synthesis of Nanomaterials by top-down and bottom-up approaches; Chemical Methods of Synthesis _Sol-Gel process, Green Synthesis of nanoparticle, Solvothermal method. Characterization of and applications of nanoparticles.

15: BIOINFORMATICS, BIOSTATISTICS AND IPR

Introduction to Bioinformatics: Bioinformatics — Online tools and offline tools. Biological databases. Types of data bases — Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.

Multiple sequence alignment and Dynamic programming. Gene and Genome annotation _Tools used. Physical map of genomes. Molecular phylogeny — Concept methods of tree construction. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to

homology modeling. Computer Aided Drug Design (CADD) in Drug discovery. Brief description and tabulation of data and its graphical representation.

Measures of central tendency and dispersion — mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance — F & t tests, chi — square tests, ANOVA.

IPR: Different types of intellectual property rights (IPR) - Patents, Trade mark, Trade secret, copyright and Geographical indications. Patent filing and Infringement Patent application forms and guidelines, Types of patent applications: Indian Patent and Patenting in Europe and US. IP relevance to Biotechnology. Biosafety , ethical impacts of biotechnology, GLP and GMP.