# Syllabus for the Recruitment Test for the post of Assistant Professor (College Cadre) in the subject of BIOTECHNOLOGY

**1.** Molecules and their Interaction Relevant to Biology

**2.** Cellular Organization

**3.** Fundamental Processes

**4.** Cell Communication and Cell Signaling

**5.** Inheritance Biology

**6.** Applied Biology

**7.** Methods in Biology

## 1. MOLECULES AND THEIR INTERACTION RELAVENT TO BIOLOGY

**A.** Structure of atoms, molecules and chemical bonds.

**B.** Composition, structure and function of biomolecules (carbohydrates, lipids, proteins and nucleic acids).

**C.** Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

**D.** Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

**E.** Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

**F.** Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanismmotif of enzyme catalysis, isozymes

**G.** Conformation of proteins (Ramachandran plot, secondary structure, domains, and folds).

**H.** Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

**I.** Stability of proteins and nucleic acids.

**J.** Metabolism of carbohydrates and lipids

## 2. CELLULAR ORGANIZATION

**A) Membrane structure and function**

Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes

**B)Structural organization and function of intracellular organelles** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

**C) Organization of genes and chromosomes** Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

**D) Cell division and cell cycle** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

**E) Microbial Physiology** Growth yield and characteristics, strategies of cell division.

## 3. FUNDAMENTAL PROCESSES

**A)DNA replication, repair and recombination** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

**B) RNA synthesis and processing** transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

**C) Protein synthesis and processing** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code,

aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.

**D) Control of gene expression at transcription and translation level:** Regulation of the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing.

**4. <u>Cell communication and cell signaling</u>**

**A) Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two- component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

**B) Cellular communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

**C) Cancer**

Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

**D) Innate and adaptive immune system:** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, Antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, vaccines.

## 5. INHERITANCE BIOLOGY

**A) Mendelian principles:** Dominance, segregation, independent assortment, deviation from Mendelian Inheritance

**B) Concept of gene:** Allele, multiple alleles, pseudoallele, complementation tests

**C) Extensions of Mendelian principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

**D) Gene mapping methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids

**E) Extra chromosomal inheritance:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

**F) Microbial genetics:** Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

**G) Human genetics:** Pedigree analysis, karyotypes, genetic disorders.

**H) Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

**I) Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

**J) Structural and numerical alterations of chromosomes:** Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

**K) Recombination:** Homologous and non-homologous recombination including transposition.

## 6. APPLIED BIOLOGY:

**A. Microbial fermentation and production of small and macro molecules:**

Isolation, preservation and improvement of industrially important microorganisms, Fermentation system and types of fermenters, fermentation raw materials, Media for industrial fermentations, Industrial production of alcohol (ethanol, wine and beer) and improvement by genetic engineering, Microbial production of acids (citric, acetic and gluconic acid) solvents (glycerol acetone and butanol) aminoacids (lysine and glutamic acid), Production of antibiotics.

**B. Application of immunological principles, vaccines, diagnostics, Tissue and cell culture methods for plants and animals:**

Live attenuated, killed, subunit, conjugate and DNA vaccines. Production of recombinant antibodies and edible vaccines, development of diagnostics and immunoprophylactics using biotech and nanotech tools,

**Plant cell and tissue culture**-,Plant cell and Callus culture, Organogenesis, somatic embryogenesis and synthetic seeds, Micropropagation,somaclonal variations,In Vitro production of haploid plants, Protoplast culture and somatic hybridization

**Animal cell and tissues culture**: Aseptic techniques , media , Primary culture, Sub-culturing ,Cell line chacterization, applications

**C. Transgenic animals and Transgenic Plants**-*Agrobacterium* mediated and Direct gene transfer methods in plants, Screenable and selectable markers, molecular characterization of transformants, Marker free methodologies and Applications of transgenic Plants

Transgenic Animals-Gene transfer in animal cells, applications, Animal genomics, Animal cloning

**D. Genomics and its application to health and agriculture, including gene therapy.**

**E. Bioremediation and phytoremediation:** Bioremediation of fuel oils and lubricants in soil and water. Degradation of sulphur compounds present in coal and petroleum. Microbial and Phytodegradation of xenobiotics, Genetic engineering of biodegradation pathways.

## 7. METHODS IN BIOLOGY

A. **Molecular Biology and Recombinant DNA methods:**

Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods.

Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.

Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors. Manipulation of gene expression in prokaryotes, Hetrologous protein production in Eukaryotes.

Isolation of specific nucleic acid sequences, Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors, methods for clone identification

In vitro mutagenesis and deletion techniques, Nucleic acid amplification, gene knock out in bacterial and eukaryotic organisms.

Protein-Protein interactions, DNA sequencing methods, strategies for genome sequencing.

Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques

RFLP, RAPD and AFLP techniques

**B. Histochemical and Immunotechniques**

Detection of molecules using ELISA, RIA, western blot, Immunoprecipitation, flowcytometry and immunofluorescence microscopy detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

**C. Biophysical Method:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, mass spectrometry. HPLC, GLC.

**D. Statistical Methods:**

Measures of central tendency and dispersal; probability distributions (Binomial,

Poisson and normal); Sampling distribution; Difference between parametric and non- parametric statistics; Confidence Interval; Errors; Levels of significance, Regression and Correlation; t-test; Analysis of variance; Chi Square test

**E**. **Radiolabeling techniques:**

Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

**F**. **Microscopic techniques:**

Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM

**G. Computational methods**

Introduction**,** Applications, Limitations, Types of Databases, Biological Databases, Pairwise Sequence Alignment, Scoring Matrices, Database Searching, BLAST, FASTA, Multiple Sequence Alignment, Position-Specific Scoring Matrices (PSSM), Profiles, Markov Model and Hidden Markov Model, Introduction to Molecular Phylogenetics.