

SYLLABUS

The syllabus for Research Methodology is common to all branches of science

Research Methodology

1. Introduction of research methodology: meaning of research, objectives of research, types of research, significance of research, problems encountered by researchers in India;
2. Research problem: definition, necessity and techniques of defining research problem, formulation of research problem, objectives of research problem
3. Research design: meaning, need and features of good research design, types of research designs, basic principles of experimental designs, design of experiments, synopsis design for research topic.

Subject Specific Syllabus (Biotechnology)

Unit 1: Cellular Architecture: Membranes, Organelles, and Intracellular Transport

- a) Cell wall and Cell Membrane: physical structure of model membranes in prokaryotes and eukaryotes; diffusion, osmosis, active transport and regulation of intracellular transport.
- b) Structural organization and functions of cell organelles: nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, lysosomes, chloroplast, peroxisomes, vacuoles. Cytoskeletons structure and motility function.

Unit 2: Molecular Processes and Mechanisms in Cellular Function and Regulation

- a) Composition, structure and function of biomolecules (nucleic acids, proteins, carbohydrates, lipids and vitamins)
- b) Fundamental processes in cell: DNA replication, transcription, post-transcriptional modifications, genetic code, translation, post translational modifications, DNA damage and repair, RNA synthesis and processing, recombination and transposition, control of gene expression.
- c) Cell division and cell cycle: Mitosis and meiosis, their regulation, cell cycle and its regulation, apoptosis, necrosis and autophagy.
- d) 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.

- e) Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.
- f) Enzymology: Introduction to enzymes. Types of enzymatic reaction mechanisms, Michaelis-Menten kinetics. Competitive, Non-competitive and Un-competitive inhibition. Allostery.

Unit 3: Immunology

- a) Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity.
- b) B and T cell epitopes, structure and function of antibody molecules.
- c) 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, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

Unit 4: Recombinant DNA Technology

- a) Enzymes used in Recombinant DNA technology.
- b) Isolation and purification of DNA (genomic and plasmid) and RNA. Various methods of separation, characterization of nucleic acids including Southern and Northern hybridizations.
- c) Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors and their purification. Western blotting.
- d) Generation of genomic and cDNA libraries. Plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.
- e) Isolation and amplification of specific nucleic acid sequences, PCR, RT PCR and qRT PCR
- f) DNA sequencing methods, strategies for genome sequencing.

- g) Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array-based techniques.
- h) Analysis of DNA polymorphism: RFLP, RAPD and AFLP techniques.
- i) Biosafety regulations and IPR.

Unit 5: Animal Tissue culture

- a) Primary culture, secondary culture, sub-culturing, cell lines, cloning and selection. Media, serum free media (advantage & disadvantages). Large scale culturing-bioreactors.
- b) Preservation and maintenance of animal cell lines. Cryopreservation and revival.
- c) Hybridoma technology, gene therapy, animal cloning and ethical issues.

Unit 6: Plant Tissue Culture and Transgenic Technologies

- a) Totipotency; Tissue culture media; Plant hormones and morphogenesis; embryogenesis; Cell suspension culture; Micropropagation – shoot tip culture, somatic embryos, artificial seeds; Applications of tissue culture; shoot tip culture; Anther culture and dihaploids.
- b) Production of alkaloids and other secondary metabolites; Protoplast isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybrids; Cybrids.
- c) Direct transformation of protoplasts using PEG; electroporation; Transformation by particle bombardment; Chloroplast transformation. Ti plasmid-based transformation; Ti and Ri plasmids, T-DNA genes, borders, Ti plasmid virulence genes and their functions.
- d) Promoters, Plant selectable markers; Reporter genes; Selectable marker elimination; Transgene silencing and strategies to avoid transgene silencing.
- e) Genetic engineering of crops; Codon optimization in the expression of genes in plants, Commercial status of transgenic plants; Herbicide resistance, glyphosate, sulfonyl urea, phosphinothricin, atrazine; Pest resistance, Bt toxin; Protease inhibitor; nematode resistance; Genetic engineering for male sterility-Barnase-Barstar; Delay of fruit ripening; polygalacturanase, ACC synthase, ACC oxidase; Improved seed storage proteins; Improving and altering the composition of starch and plant oils; Golden rice for β -carotene accumulation; Production of antibodies and pharmaceuticals in plants.

- f) Biofuels, *Bacillus thuringiensis*: molecular basis of insecticidal activity. Agriculturally important microorganisms and their application. Environmental pollution, Bioremediation, Biodiversity and conservation.