**Paper I: Research Methodology**

Max marks:100 Min marks:50 Time: 3hrs

**Unit 1: Biochemical techniques:**

Electrophoresis: Agarose gel electrophoresis, native PAGE, SDS-PAGE, 2D gel electrophoresis, Isoelectric focusing. Blotting techniques: Southern, Northern and Western blotting. Far Western blotting, Immunoprecipitation and co-immunoprecipitation. Centrifugation: Principle, types (differential, density gradient) and applications. Ultracentrifugation. Chromatography: Principle and types (Ion exchange and affinity) Basic cell culture techniques, cell viability assays, basic microscopy techniques.

**Unit 2: Bioinformatics and Biostatistics:**

Bioinformatics: Commonly used sequence formats (FASTA and Swissprot format, European Molecular Biology Laboratory data library format), Sequence alignment (progressive methods of multiple sequence alignment-CLUSTALW, PILEUP)

Biostatistics-Using statistics to summarize Data Sets (mean, mode, median; Sample Variance and Sample Standard Deviation).Testing statistical hypothesis: Hypothesis Tests and Significance Levels; Tests Concerning the mean of a Normal Population: Case of known Variance; The t Test for the mean of a Normal Population: Case of Unknown Variance. Chi-squared goodness-of fit tests.

**Unit 3: Scientific Writing**

Research, Types and Formulations; Meaning of Research, Objectives of Research, Motivation in Research; Research methods vs. Methodology. Types of research-Descriptive vs Analytical, Applied vs Fundamental, Quantitative vs Qualitative, Conceptual vs Empirical; Research Process; Criteria of good Research. Formulating the research problem: Selecting problem: Importance of literature review in research; Sources of literature Review-primary and secondary sources, reviews, treatise, monographs, patents, journals, books and internet resources; Identifying research gap areas from literature review. Hypothesis, important considerations while making a hypothesis.

**Unit 4: Research Ethics**

Ethics in Research: Introduction to Bioethics. Ethical issues concerning various fields of biology; embryonic stem cells and cloning, gene therapy and designer babies, genetically modified animals and crops. Ethical limits of animal use and welfare. Medical research ethics. Plagiarism and academic integrity. Mentor and mentee responsibilities and relationships. Record keeping, data, responsible authorship and publications. Conflict of interest.

**Paper II: Recent Advances in the subject**

Max marks: 100 Min marks: 50 Time:3 hrs

**Unit 1: Biotechnology and Human Welfare**

Gene Cloning: Principle and applications. PCR and types, site directed Mutagenesis. Transformation and transfection. Agri-Biotechnology and healthcare: GM crops, GM crops based products, GE bacteria for agriculture. Genetically engineered pharmaceuticals: human insulin, human growth hormone. Hepatitis B Vaccine, interleukins, AIDS vaccine.

**Unit 2: Cell Signalling and Communications**

General principles of cell communication. Nuclear receptors, Cytoplasmic receptors. Signally through GPCR receptors. Signaling through enzyme linked cell surface receptors. Ligand Gated Ion Channels. Heat shock and ER stress response. Molecular events in cancer progression. Oncogenes and tumor suppressors. Signaling in plants.

**Unit 3: Immunobiology**

Generation of antibody diversity and TCR rearrangement. Major histocompatibility complex, Antigen presentation, APCs. T-cell development, negative/Positive selection, Co-stimulatory molecules. Humoral immunity/Cell-mediated immunity, T cell subtypes: Th1, Th2,Th17,Tregs etc. B-cell maturation/activation BCR signalling. Pro inflammatory and anti-inflammatory cytokines. Cell polarization/complement activation (classical/alternate), Vaccines, memory B and T cell responses, active immunization, passive immunization, Vaccine production.

**Unit 4: Epigenetics**

Eukaryotic genome. Chromatin. Nucleosome structure. Chromatin organization. Different levels of chromatin organization from nucleosome to chromosome territories (including topologically associating domains).Relationship between chromatin organization and gene expression. Modulation of Chromatin structure. Overview of non-coding RNA and their important role in current research. Biogenesis of small ncRNA, piRNA, esiRNA. Long non-coding RNA and their importance in gene regulation.