



# DAV UNIVERSITY, JALANDHAR

PhD Entrance Test Syllabus

## DEPARTMENT OF BIOTECHNOLOGY

### Section A (50 questions)

#### Research Methodology

**Descriptive statistics:** Definition and relevance in biological research; Measures of Central Tendency: Arithmetic Mean, median, mode, quartiles and percentiles; Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis. Probability Theory.

**Inferential statistics:** Hypothesis testing, Errors in Hypothesis Testing- Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance. One tailed and Two- tailed tests.

Correlation and Regression: Correlation coefficient ( $r$ ), properties, interpretation of  $r$ , partial and multiple correlations, linear regression: Fitting of lines of regression, regression coefficient, Bivariate and Multiple Regression.

**Parametric and Non-Parametric Statistics:** Definition, Advantages, Disadvantages, Assumptions;

**Parametric Tests:** Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance; Non-

**Parametric Tests:** Analysis of Variance, Chi square and Kendall Rank Correlation. Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design; Split plot design and Factorial design. Data collection, organization and interpretation. Research articles, research papers, popular research articles and reviews; difference between periodicals; journals; monographs, magazines; proceedings. Science citation index; H-index, i10 index, Impact factor calculation, Impact factor of a journal; Eigen factor, Major journal search engines. Copyright act; Academic frauds; Plagiarism; Software's to check plagiarism.

### Section B (50 questions)

#### Biotechnology

**Cell Biology:** Cell theory, General organization and diversity of prokaryotic and eukaryotic cells. Assembly of macromolecules, mechanism of assembly, evolutionary steps in the origin of cells. 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. Membrane structure and function. Membrane protein diffusion, osmosis, ion channels, active transport, mechanism of sorting and regulation of intracellular transport. Targeting proteins to endoplasmic reticulum, Protein sorting and export from Golgi apparatus, Protein import into Mitochondria, Import and sorting of chloroplast protein. Cell division and Cell cycle & its regulation, the role of the cyclins and cyclin-dependent kinases, cell cycle checkpoints. Mechanism of signal transduction: Cell signaling - Modes of cell signaling, steroid hormone receptors, plant hormones, G-protein coupled receptors; regulation of signaling pathways, Ras, Raf, MAP kinase pathway.

**Genetics:** Molecular organization of chromosomes, Genome size and complexity, structure of eukaryotic and prokaryotic chromosome, polytene chromosomes, euchromatin and heterochromatin, satellite DNA, centromere and telomere structure, chromosomal staining. Structure of chromatin and chromosomes, heterochromatin, euchromatin, transposon. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Mendelian principles:



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Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Polygenic inheritance, QTL mapping, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

**Extrachromosomal inheritance:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance, Split genes, overlapping genes and pseudo genes. Spontaneous and induced mutation, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis, site directed mutagenesis, molecular basis of mutagenesis, test for mutagenicity, mutation frequency, transformation, transduction, conjugation, transposable elements and transposition. Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses. Virus-like agents: Prions, satellite DNAs and RNAs, satellite viruses; defective interfering particles and virophages.

**Recombinant DNA Technology:** Introduction and scope of Recombinant DNA Technology. DNA modifying enzymes, Linker, Adaptor, Homopolymer tailing, Restriction Endonucleases. Isolation and Purification of nucleic acid: Basic techniques and criteria of purity. Characteristics of cloning and expression vectors, plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors, bacterial, yeast, plant, viruses and mammalian expression vectors. Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone. Nucleic acid Blotting, Protein-Protein interactions, Polymerase chain reaction, site directed mutagenesis and protein engineering. Applications of r-DNA technology in industry, agriculture and forensic science.

**Tools in Biotechnology:** Quantitative and real time PCR, Nucleotide sequencing, Protein DNA interaction assays, Radioimmunoassay, ELISA, Flow cytometry, Overview of Chemical and Physical cell disruption techniques for biomolecules. Methods of separation of peptides and proteins, oligonucleotides and DNA by electrophoresis and chromatography. Advanced techniques of separation: 2D gel electrophoresis, HPLC and GC. Detection of molecular mass by MALDI, ESI-MS and structure of molecules by Nuclear Magnetic Resonance spectroscopy, <sup>1</sup>H NMR, <sup>13</sup>C NMR, Magnetic Resonance Imaging. Methods of virus diagnosis, detection, assays and comparison of their sensitivities. Techniques employed for structural and functional genomics of viruses. Transcriptomics: Microarray, EST, SAGE. Bioinformatical methods in transcriptomics. Genome sequencing projects: technology of sequencing and assembly. Next generation sequencing using new technologies. Protein-DNA interaction, DNA microarray for cancer profiling.

**Nano-Biotechnology;** Science of Nanobiotechnology, type of nanoparticles and nanomaterials. Nanoparticles in biological labeling and cellular imaging, functionalized protein-based nanostructures, Nanomotors. Interaction of Nano-Materials with Cell/ Biosystems: Proteins, Lipids, RNA and DNA. Nanobiosensors: From Natural to Artificial Structures, Nano Printing of DNA, RNA and Proteins, Nano Scale Detection Lab-on-a-chip Devices (LOC). Nanostructures in Drug discovery, delivery, and controlled release, Nanotechnology for tissue engineering, in regenerative therapy. Nanoparticles for the detection and treatment of cancer, Nano-targeted delivery systems: Colloidal drug carriers, nanoparticles and liposomes. Role of nanotechnology in biological therapy, nano devices in medicine and surgery.

**Plant Biotechnology:** Plant tissue culture, cellular totipotency, conventional breeding. Tissue culture media, sterilization techniques, callus and suspension cultures, single cell clones, nurse culture technique,



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differentiation, organogenesis & somatic embryogenesis, artificial seeds. Micropropagation, Clonal propagation, production of virus-free plants, propagation by direct and indirect organogenesis. In situ and ex situ rooting & difference. Changes during hardening of micropropagated plants. Somaclonal and gametoclonal variations and their practical application. Protoplast culture, somatic hybridization and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids, haploid production, anther, pollen culture, monoploid production, hybrid embryo culture/embryo rescue and ovary culture, endosperm culture, production of triploids. Role of following in agriculture improvement. Germplasm conservation techniques. Transgenic Plants Technology, Molecular mechanism of Agrobacterium mediated transformation, selection and reporter markers, Selection of transgenic and marker free transgenics. Role of viruses in plant biotechnology, gene transfer, plant virus and viroid induced diseases in economically important trees and agricultural crops and their control

**Computational Biology & Bioinformatics:** Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases, Protein structure databases, Sequence motif databases, Sequence, structure and function relationship. Analysis and submission of EST and GSS data, clustering of ESTs. Whole Genome annotation strategies: Basic overview of whole genome annotation strategies, strategies for Human and Arabidopsis genomes. Introduction to DNA and Protein sequencing, Human Genome Project.

**Molecular Biology:** DNA as genetic material, Structure of DNA, RNA, their types. Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of replication, Bi-directional replication, DNA polymerases. The replication complex: Pre-priming proteins, primosome, replisome, rolling circle replication, unique aspects of eukaryotic chromosome replication, Fidelity of replication. DNA damage and mechanism of repair. Homologous recombination: models and mechanism. Transcription in prokaryotes and eukaryotes: Prokaryotic RNA polymerase, Eukaryotic RNA polymerases, sigma factor, transcription factors, promoter, enhancers, initiation, elongation and termination of RNA chains. RNA splicing and processing of pre-mRNA. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics. Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection. Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Post-translational modifications of proteins.

**Research Methodology:** Descriptive statistics, relevance in biological research, Measures of Central Tendency: Arithmetic Mean, median, mode. Measures of Dispersion: Range, variance, standard deviation, coefficient of variation. Probability: Type of events, their calculation for probability, theorem of addition and multiplication and calculations. Hypothesis testing, Errors in Hypothesis Testing- Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance. One tailed and Two- tailed tests. Correlation and Regression: Correlation coefficient ( $r$ ), properties, interpretation of  $r$ . Parametric and Non-Parametric Statistics: Definition, Advantages and Disadvantages. Parametric Tests: Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance; Non-Parametric Tests: Analysis of Variance, Chi square. Research articles, research papers, difference between



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