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DOCTORAL ENTRANCE EXAMINATION - BIOTECHNOLOGY
EXAM SCHEME

TIME: 2 HOURS MAXIMUM MARKS: 100

The candidates must score minimum 50% marks in the entrance test to qualify for the interview.
The Doctoral Entrance Test will have the question paper in two parts.

PART A – 50 Marks

It shall be of generic nature, intended to assess the research aptitude of the candidate. This part shall carry 50 objective type compulsory questions pertaining to General Science, Quantitative Reasoning, Data Interpretation & Analysis and Research Aptitude. The candidates shall be required to answer all questions. Each question shall be of one mark. There will be no negative marking.

PART B – 50 Marks

Part-B shall also consist of 50 objective type compulsory questions of 1 mark each based on the subject of the research covering the topics given in the syllabus. Each question shall be of one mark. There will be no negative marking.

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SYLLABUS FOR PART B

BIOCHEMISTRY & MOLECULAR BIOLOGY

- Structure of atoms, molecules and chemical bonds.
- Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
- Membrane structure and function, Membrane transport
- Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
- Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
- DNA replication, repair and recombination
- RNA synthesis and processing
- Protein synthesis and processing
- Post-transcriptional and translational modifications
- Stability of proteins and nucleic acids.
- Organization of genes and chromosomes
- Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.
- Molecular interaction,
- protein-protein interactions,

CELL BIOLOGY, CELL COMMUNICATION AND CELL SIGNALLING

- Structure and regulation of prokaryotes and eukaryotes genes
- Cell division and cell cycle
- Microbial Physiology
- Host parasite interaction
- Cell signalling
- Cellular communication
- Cancer
- Innate and adaptive immune system
- Signal transduction pathways and their elucidation,

DEVELOPMENTAL BIOLOGY

- Basic concepts of development
- Gametogenesis, fertilization and early development:
- **Morphogenesis and organogenesis in animals:** *Drosophila, Dictyostelium, amphibian C.elegans* vertebrates etc.
- **Morphogenesis and organogenesis in plants:** *Arabidopsis and Antirrhinum*
- Programmed cell death, aging and senescence

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GENOMICS & BIOINFORMATICS

- Systems biology frameworks for metabolic engineering,
- Genomics and proteomics,
- Major bioinformatics resources (NCBI, EBI, ExPASy);
- Sequence and structure databases and analysis
- Multiple Sequence Alignment, Phylogenetic Analysis
- Comparative genomics;
- Molecular modeling and simulations.
- Molecular markers, genetic and physical mapping,
- Gene interaction;
- Population genetics;
- Cloning and expression vectors,
- rDNA technology, gene cloning approaches,
- Whole genome sequencing & annotation,

System Physiology

- **Plant** – Photosynthesis, Respiration and photorespiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Solute transport and photoassimilate translocation, Secondary metabolites & Stress physiology

- **Animal** - Blood and circulation, Cardiovascular System, Respiratory system, Nervous system, Sense organs, Excretory system, Thermoregulation, Stress and adaptation, Digestive System, Endocrine and reproduction System.

INHERITANCE BIOLOGY

- Mendelian principles, Concept of gene
- Extensions of Mendelian principles
- Gene mapping methods, Extra chromosomal inheritance,
- Microbial genetics
- Human genetics, Quantitative genetics
- Mutation
- Structural and numerical alterations of chromosomes
- Recombination

ECOLOGICAL PRINCIPLES AND EVOLUTION

- The Environment, Habitat and Niche, Population Ecology, Species Interactions, Community Ecology, Ecological Succession, Ecosystem Ecology, Biogeography, Conservation Biology
  Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

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- **Origin of cells and unicellular evolution:** Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

- **Paleontology and Evolutionary History:** The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

- **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

- **Population genetics** – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

APPLIED BIOLOGY:

- Microbial fermentation and production of small and macro molecules.
- Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals.
- Transgenic animals and plants, molecular approaches to diagnosis and strain identification.
- Genomics and its application to health and agriculture, including gene therapy.
- Bioresource and uses of biodiversity.
- Breeding in plants and animals, including marker – assisted selection
- Bioremediation and phytoremediation
- Biosensors

BIOPROCESS AND MICROBIAL TECHNOLOGY

- Primary and secondary metabolites, Batch culture, the growth cycle, effect of nutrients, energetics of growth.

- **Design of bioreactors:** Biosensors, scale up of bioreactors

- **Transport phenomena in bioprocess**: Mass transfer resistance, oxygen transfer coefficients, biological heat transfer, heat transfer coefficients.

- **Downstream processing of biologicals**: Separation of cells, foam separation, flocculation, filtration, plate filters, rotary vacuum filter, centrifugation, Stokes law, basket centrifuge, bowl centrifuge, disintegration of microorganisms, mechanical and non-mechanical methods, membrane filtration, ultra filtration and reverse osmosis, chromatographic techniques, absorption, spray drier, drum dryers, freeze dryers.

- **Microbial products**: Microbial production of vitamins, enzymes, organic acids, amino acids, antibiotics, ethanol.

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- **Microbes for sustainable agriculture**: Biological nitrogen fixation, Biofertilizers, Biological control, Biopesticides.

BIOLOGICAL TECHNIQUES

- Mass spectrophotometry,
- Nanobiotechnology,
- Blotting techniques,
- Gene transfer technologies,
- high throughput gene expression (micro array, DNA chips) and function elucidation technologies,
- PCR, RT-PCR, FISH and GISH
- 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; X2 test.
- Radiolabeling techniques

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