॥वसुधैव कुटुम्बकम्॥

SYMBIOSIS INTERNATIONAL (DEEMED UNIVERSITY)

(Established under section 3 of the UGC Act 1956)

Re - accredited by NAAC with 'A' Grade (3.58/4)| Awarded Category- I by UGC

Founder: Prof. Dr. S. B. Mujumdar, M.Sc., Ph.D. (Awarded Padma Bhushan and Padma Shri by President of India)

Faculty of Health Sciences (FOHS)

Syllabus for PhD Entrance Test (PET)

❖ BIOTECHNOLOGY

Unit 1: Biochemistry

1. Structure and function of biomolecules- carbohydrates, lipids, proteins, nucleic acids, and vitamins. Principles of biophysical chemistry (pH, buffer, reaction kinetics).

2. Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

3. Principles of enzymology, enzyme kinetics, enzyme regulation, enzyme inhibition, isozymes.

4. Carbohydrate metabolism (glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, and pentose phosphate pathway), TCA cycle and oxidative phosphorylation

5. Methods in Biochemistry: Various assays for the estimation of protein, carbohydrates and nucleic acids, chromatography, electrophoresis, enzyme assays.

Unit 2: Cell Biology

1. Structural organization and function - Lipid bilayer, intracellular organelles, overview of cytoskeletal filaments, cell adhesion molecules, extracellular matrix proteins, overview of vesicular trafficking and mechanisms of protein sorting.

2. Cell cycle and apoptosis - Mitosis and meiosis, overview of the cell cycle and its regulation, cell cycle check points, characteristics of apoptotic cells, intrinsic and extrinsic apoptotic pathways, and assays to study cell cycle and apoptosis.

3. Cell signaling- Principles of cell communication by cell surface receptors, paracrine signaling-autocrine signaling-endocrine signaling-signaling by plasma membrane attached proteins, agonists-antagonists-allosteric activator-allosteric antagonist, examples of cell signaling pathways with their functional importance.

4. Cancer- Cancer theories that depict the onset and progression of cancer, role of oncogenes and tumor suppressor genes, characteristics of cancer cells and the mechanism(s) behind metastasis.

Unit 3: Genetics

1. Principles of inheritance: Mendelian genetics, chromosomal theory of inheritance, non-Mendelian inheritance (e.g. co-dominance, incomplete dominance, genetic linkage etc.), linkage maps.

2. Nature of genetic material: Griffith's transforming principle, experiments that proved DNA as the genetic material (e.g. Avery, McLeod and McCarty, and Hershey and Chase), Structure of DNA.

3. Methods in human genetics: Population genetics (Hardy-Weinberg equation), pedigree analysis (autosomal and sex-linked inheritance of dominant and recessive traits), DNA based methods of genetic analysis (e.g. RFLP, AFLP, RAPD etc.).

Unit 4: Molecular Biology

1. DNA replication: General properties of DNA replication and DNA polymerases, modes of DNA replication (e.g. theta replication, rolling circle etc.), regulation of replication initiation (e.g. repA, cyclins, cdks etc.) and termination (e.g. ter proteins, telomerases etc.).

2. Transcription: Structural features of a gene (e.g. promoters, enhancers etc.), operon concept, mediators of transcription (e.g. RNA polymerases, general transcription factors etc.), types of RNA (e.g. mRNA, rRNA, tRNA etc.), RNA processing (e.g. capping, splicing, polyadenylation etc.), transcription regulation in eukaryotes (DNA methylation, histone modifications, epigenetics etc.) post-transcriptional regulation in eukaryotes (e.g. RNAi, RNA editing etc.).

3. Translation: Genetic code, codon bias, ribosome structure and assembly, translation initiation, elongation and termination, regulation of translation, nonsense mediated decay, post-translational modifications of proteins.

4. DNA repair: Mutations and mutagens, types of DNA damage, DNA repair pathways (e.g. BER, NER, NHEJ etc.), diseases associated with defective DNA repair.

5. Methods in molecular biology: Methods of nucleic acid extraction and purification (e.g. phenol-chloroform extraction, agarose gel electrophoresis), Methods to study DNA-protein interaction (e.g. EMSA, DNA-footprinting etc.), hybridization based methods of nucleic acid estimation (e.g. Southern blotting, northern blotting, fluorescent *in situ* hybridization etc.)

Unit 5: Microbiology

1. Microbial Physiology – Cell structure and function, Principles of microbial growth

2. Antimicrobial resistance – Antimicrobials types and modes of action, factors affecting development and transmission of AMR

3. Bacteriophages – Structure, Classification, Infection cycle and mechanism, Applications

4. Microbiome – Biofilms, Quorum Sensing, Probiotics, Prebiotics, Synbiotics

5. Principles of isolation – Principles of microbial culture, Aseptic techniques, Principles and methods of sterilization, isolation and enumeration of microorganisms, staining techniques

6. Microbial pathogenesis - Host pathogen interactions, epidemiology of infectious diseases

7. Food microbiology – Food borne pathogens, Principles of food preservation, microbiological examination of food and water

Unit 6: Immunology

1. Innate and adaptive immune system- Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity, and immunogenicity.

2. Humoral and cell mediated immunity, primary and memory immune responses, B and T cell receptors, structure and function of antibody molecules, monoclonal antibodies, antibody engineering. MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells.

3. Inflammation, allergy, and hypersensitivity reaction. Immunological tolerance - self non-self descrimination.

4. Immunological techniques- ELISA, ELISPOT, Immunofluorescence, Western blot, Flow Cytometry.

Unit 7: Recombinant DNA technology and genetic engineering

1. Isolation, purification, analysis of RNA and DNA (genomic and plasmid). Molecular cloning of DNA and RNA fragments in cloning vectors and expression. Construction of genomic and cDNA libraries and screening.

2. Cell and Tissue engineering- Growth factors for *in situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Hemoglobin-based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering. *In vitro* fertilization and Embryo transfer- *In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animals e.g: Cow.

3. Cloning of Animals- Methods and uses. Introduction, the nuclear transfer for cloning, cloning from-embryonic cells, adult and fetal cells. Cloning from short-term and long-term cultured cells: cloning of sheep, Cloning of cows from aged animals. human cloning-ethical issues and risks. Transgenic animals- Transgenic animals and applications: mice and other animals,

4. Biosafety regulations- guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms.

Unit 8: Genomics, Proteomics and Bioinformatics

1. Protein and DNA Sequencing: Methods of DNA and protein sequencing (e.g. Edman degradation, Sanger sequencing etc.), genome assembly and analysis (e.g. Shotgun sequencing etc.), high-throughput DNA sequencing methods (NGS) and single cell sequencing, mutation analysis using NGS methods (Exome and clinical exome sequencing).

2. Functional genomics and proteomics: Gene expression analysis methods (e.g. qPCR, SAGE, Microarray technology, RNA-sequencing etc.), Gene regulation methods (e.g. ChIP-seq, Ribo-seq, methylome analysis etc), quantitative mass spectrometry (e.g. SILAC, ICAT, iTRAC, label free quantitation etc.).

3. Structural biology and informatics: Methods of structure determination (e.g. X-ray crystallography, NMR, electron microscopy etc.), methods of protein structure visualization (e.g. PyMOL, RasMol etc.), structure prediction methods (e.g. ITASSER, ROBETTA etc.), molecular simulation and dynamics (e.g. GROMACS, AMBER etc.), docking analysis (e.g. Autodock etc.).

4. Biological databases: Sequence databases (e.g. Genbank, SwissProt etc.), structure databases (e.g. PDB etc.), raw data (e.g. GEO, PRIDE etc.), database management (e.g. MySQL, PHP etc.)

Unit 9: Bioprocess and Microbial Technology

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

2. Design of bioreactors- Biosensors, scale-up of bioreactors

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

4. 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, ultrafiltration and reverse osmosis, chromatographic techniques, absorption, spray drier, drum dryers, freeze dryers.

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

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

Unit 10: Research Methodology and Biostatistics

1. Research Methodology- Types of research, Types of research designs, Qualitative and quantitative research, applied research, Sampling methods, and Preparation of a research proposal.

2. Basic statistics- Types of data, central tendencies and dispersion, graphs and tables, correlation and regression analysis, probability, types of errors in statistics, sensitivity and specificity.

3. Statistical test (e.g. Chi-square test, Student's t-test, Mann-Whitney test, ANOVA, , Kruskal Wallis test etc.), measure of significance.