॥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 Medical and Health Sciences (FOMHS)

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: A) Mendelian genetics: Rediscovery and statistical testing (Chi-Squared test), exceptions to Mendel's laws. B) Cytogenetics: mitosis and meiosis, sex-determination and chromosomal theory of inheritance, sex-linkage and linkage maps, C) Abnormalities in chromosome number, D) population genetics and Pedigree analysis,

2. Molecular genetics: A) DNA as the genetic material: Griffith's transforming principle, Avery, McLeod and McCarty experiment, and Hershey and Chase experiment, B) Structure of DNA, semiconservative replication Genetic code, C) Chromosome banding and abnormalities in chromosome structure, D) Molecular markers: Southern blotting and RFLP, PCR and RAPD, E) Repeat elements and DNA fingerprinting F) Somatic cell and radiation hybrids, G) Physical mapping: FISH, STS mapping.

3. Complex traits: A) Statistical analysis of complex traits, B) Epigenetic inheritance, C) Fundamentals of genomics

Unit 4: Molecular Biology

1. DNA replication: General properties of DNA replication and DNA polymerases, modes of DNA replication, regulation of replication initiation in prokaryotes, cell cycle checkpoints, termination of DNA replication in prokaryotes, telomeres and telomerases.

2. Transcription: Structural features of a gene, operon concept, types of RNA, RNA polymerases and transcription factors, mediator complex, RNA processing, DNA methylation, histone modifications, RNAi.

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.

Unit 5: Genomics, Proteomics and Bioinformatics

1. Methods of separation and sequencing of proteins and nucleic acids: A) Methods of precipitation such as salt and solvent precipitation. Methods of separation such as chromatographic separation (molecular sieve, ion exchange, affinity), electrophoretic separation (AGE, PAGE), isoelectric point based and density-based methods of separation), B) Methods of DNA and protein sequencing (e.g., Edman degradation, Sanger sequencing etc.).

2. Methods of analysis of sequences: A) Global and local sequence alignment, B) Pairwise and multiple sequence alignment, C) substitution matrices, D) biological databases, E) database search algorithms (FASTA, BLAST).

3. Methods of functional analysis of genes: Methods of genetic variation, gene expression, DNA methylation, and DNA protein interaction methods. Specifically, A) sequencing-based methods (DNA foot-printing), B) blotting based methods (Northern blot, Western blot, ChIP-Southern blot), C) PCR (MSP, BSP, COBRA) and quantitative PCR based methods (e.g., RT qPCR, MethylLight). D) Tools in functional gene analysis such as primer designing.

4. Genome sequencing: A) Vectors in genome sequencing e.g., phage-based vectors, plasmids, cosmids, YACs, and BACs. B) Shotgun sequencing, primer walking, and hierarchical shotgun sequencing. C) Genome sequence databases and search algorithms. D) Genome assembly and gene annotation

5. Functional genomics: A) Sequencing based methods such as SAGE, CAGE, SELEX. B) Microarray based methods such as expression microarray, array CGH, SNP and methylation arrays, C) High-throughput DNA sequencing (NGS) based methods: RNA-sequencing, bisulfite sequencing, ChIP-sequencing, exome and clinical exome sequencing. D) Storage, retrieval, and analysis of high throughput data.

6. Proteomics: A) Immunological methods of protein analysis such as ELISA, Lateral Flow Assay (LFA), B) Fundamentals of mass spectrometry - methods of soft ionization: MALDI and ESI; mass analyzers: TOF, quadrupole, and ion trap; C) Mass spectrometry in protein identification: PMF, MuDPIT. D) Mass spectrometry in protein quantitation: metabolic labeling (SILAC), enzymatic labeling, chemical labeling (ICAT, iTRAQ, TMT), label free quantitation.

7. Tools in functional genomics and proteomics analysis: A) Gene ontology and pathway enrichment, B) Volcano plots, heatmaps and GSEA plots.

Unit 6: 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 7: 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 8: 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 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.