Ph.D. Entrance Exam

Subject: Biotechnology

Syllabus

Cell Biology

Cell as a basic unit of life, cell theory, organization of plant and animals cells, comparison of microbial, plant and animal cells.

Structure and functions of endoplasmic reticulum, golgi complex, ribosome lysosomes, peroxisomes (glyoxysomes), plastids and mitochondria. Biogenesis of mitochondria and chloroplast, The structural and functional organization of cell membrane, ionic transport (Passive and active transport) the extra cellular matrix of eukaryote's cell wall.

Cell division and cycle: Mitosis, meiosis, cell cycle regulation, cell junctions, cell adhesion and extracellular matrix, programmed cell death, cell signaling, signaling molecules and their receptor.Intracellular signal transduction pathway, signaling network.

Cytosleleton and Cell motility: Microtubules, microfilaments and intermediate elements.

Biomolecules and its Metabolism

Structure of water molecule and Hydrogen bonding, pH, Buffer and Biological Buffer System, Henderson-Hasselbalch equation,

Carbohydrate: Structure, Classification, Properties and function of carbohydrate, Glycolysis, gluconeogenesis, Lipid: - Structure classification and function of lipid. Structure and function of fatty acid,

Protein: - Classification, Primary, Secondary and tertiary structure of protein, function of protein. Amino acid: - Structure functions and properties of Amino acids, essential and non essential amino acids, Biosynthesis and degradation of following amino acids: alanine, serine, lysine cysteine, arginine, methionine, tryptophan, phenylalanine glutamine

Nucleic acid: - Structure and types, Nucleotides & Nucleosides, Biosynthesis of purines and pyrimidines, nucleosides and nucleotides. Degradation of purines and pyrimidines.Nucleic acid-protein supramolecular complexes, Salvage pathway

Enzymes: - Introduction, Nomenclature and classification of enzyme, Factor's affecting the rate of reaction, Miechelis -menton equation. Co-enzymes:- Definition, NAD, FAD & TPP, Cofactor, Vitamins: - Fat soluble vitamin its types and function water soluble vitamin. Its types and function.

General and Applied Microbiology

Difference between prokaryotic and eukaryotic organisms, Method of Microbiology: Pure culture techniques, sterilization techniques, principle of microbial nutrition, perpetration of culture media, enrichment culture techniques for isolation of microbes, Basic principle and techniques used in bacterial classification. Phylogenetic polyphasic taxonomy, General characteristics, Morphology, Classification and structure of plant, animal and bacterial viruses, Adenoviruses, Herpes, Retrovirus, Viroids and prions.

Antibiotics and its mode of action, Microbial flora of soil, Interaction among soil microorganisms. Nitrogen fixation (a brief account), Symbiotic association-types, functions and establishment of symbiosis. A. *niger, yeast, pseudomonades putida*,

Techniques used in Biotechnology

Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission Electron Microscopy, Preparative and Analytical Centrifuges, Sedimentation analysis RCF, Density Gradient Centrifugation, Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC and HPLC, Theory and Application of PAGE, Agarose Gel Electrophoresis 2DE, Iso-electric Focusing, Immuno diffusion, Immuno Electrophoresis , ELISA , RIA , Southern , Northern and Western Blotting, Theory and Application of UV and Visible Spectroscopy, MS, NMR, Raman Spectroscopy . MALDI, Introduction to Radioisotopes and their Biological Applications, Solid and Liquid Scintillation Counter, Autoradiography, RIA , Radiation Dosimetry

Molecular Biology

DNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures. Different forms of DNA, Forces stabilizing nucleic acid structure. Super coiled DNA. Properties of DNA, Renaturation and denaturation of DNA. Tm and Cot curves, Structure of RNA.

General features of DNA replication, Enzymes and proteins of DNA replication. Models of replication. Prokaryotic and eukaryotic replication mechanism. Reverse transcription

Mechanism of transcription in prokaryotes and eukaryotes. RNA polymerases and promoters. Post-transcriptional processing of tRNA. rRNA and mRNA (5’ capping, 3’ polyadenylation and splicing). RNA as an enzyme- Ribozyme.

Genetic code, General features, Deciphering of genetic code, Code in mitochondria, Translational mechanism in prokaryotes and eukaryotes, Post translational modifications
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Regulation of Gene Expression in Prokaryotes and Eukaryotes: Operon concept, Positive and negative control, Structure and regulation of lac, trp and arb operon, regulation of gene expression in eukaryotes (a brief account), anti-sense RNA, RNAi

Genetic Engineering

Historical background, Restriction enzymes and modifying enzymes, Restriction mapping, Construction of chimaeric DNA, Isolation and purification of DNA from bacteria, plant & animal cell, Blunt end ligation.

Vehicles for gene cloning, Plasmids, Bacteriophages, Cosmids and Phagemids as vectors, P1 vectors, F- factor based vectors, Plant and animal viruses as vector, Artificial chromosomes as vectors (YAC, BAC, PAC and MAC vectors), Expression vactors- use of promoters and expression cassettes, Bacculoviruses as expression vectors, Virus expression vectors, Binary and shuttle vectors.

Methods of gene isolation, Construction and screening of genomic and cDNA libraries, Chromosome walking, Chromosome jumping, DNA sequencing Techniques (Maxam Gilbert's chemical degradation methods and Sanger's dideoxy chain termination method), Automated DNA sequencing, pyrosequencing

Construction of molecular maps (genetic and physical maps), DNA chip Technology & Microarrays (a Brief account), Whole genome sequencing and functional genomics (a brief account), Applications of genomics and Proteomics with special reference to *Arabidopsis* and Rice.

Plant Biotechnology

Introduction to plant cell and tissue culture: Tissue culture media, Initiation and maintenance of callus and suspension cultures; single cell clones. Biochemical production, Totipotency: Organoganesis; somatic embryogenesis; transfer and establishment of whole plants in soil (hardening). Rapid clonal propagation and production of virus -free plants, *In vitro* pollination; embryo culture and embryo rescue.

Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids, nuclear cytology of cultured plant cells and somaclonal variations. Production of haploid plants and their utilization, Cryopreservation and slow growth for germplasm conservation.

Ti and Ri plasmid and viral vectors (CaMV based vectors, Gemini virus, TMV based vectors). Mechanism of DNA transfer, role of virulence genes, use of 35S promoters, genetic markers, use of reporter genes, methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing , herbicide , insect and salt resistance , Plant DNA fingerprinting - Hybridization and PCR based markers (RFLP, SSRs, RAPD, QTLS , SCARS , AFLP etc.)

Biological nitrogen fixation and biofertilization, molecular mechanism of nitrogen fixation, genetics of nif gene, Plant diseases- general account, biological control of pests and disease, biopesticides, Transgenic plants and Patenting of biological.

Immunology and Animal Cell Culture

An introduction and historical perspective , antigens and antigenicity , addjuvants , immune system organs , tissues & cell lymphocytes , lymphoid organs , mono nuclear phagocytic system, mycloid system , immunity – active & passive , Natural humoral and cellular immunity,

Structure of IgG (b) , various classes of antibodies, monoclonal antibodies (hybridoma technology), Classical and alternate pathways, Major Histo-compatibility Complex, recognition of antigens by T & B cells, T – cell receptor complex, B – cells receptor complex. Dendritic cells and N cells, recombinant vector vaccines, synthetic peptide vaccines and subunit vaccines, DNA vaccines.

An introduction, concept of aseptic techniques, animal tissue culture media, cell propagation, preservation and storage of cells, detection of contamination, safety consideration in laboratory cell culture, monolayer culture technique, measurement of growth and viability of cell, Concept of bioreactors for mass culture of mammalian cell, Cell immobilization techniques, FISH and application of animal cell culture, 3-D animal cell culture and tissue engineering.

Bioprocesses & Biochemical Engineering

Introduction to Bioprocesses Engineering. Isolation, Preservation & Maintenance of Industrial microorganisms. Factors that influence solid- state fermentation. Kinetic of microbial growth an death, Media for industrial fermentation, Strain improvement of industrially important microorganism. Bioreactors: Principle, Kinetics, types, design, analysis and application.Types of fermentation processes: analysis of batch, Fed-batch and continuous Bioreactions, stability of microbial reactions, Downstream processing

Applied Biotechnology

Microbial strain of industrial importance, microbial production of antibiotics (penicillin , streptomycin & tetracycline),Vitamins (Vit B12), amino acids (glutamic acid) & enzymes (amylase, protease, invertase & pectinase), microbial production of alcoholic beverages (whisky & brandy), vinegar, citric acid, acetic acid, glycerol, acetone, foods–SCP, Biotransformation of steroids and pesticides,

Characterization and Techniques of fermentation systems. Role of Fermentation,

Role of biofertilizers and biopesticides in sustainable development, petrocrops, aquaculture, Improvement of nutritional value of seed storage protein, starch, oil,

Prokaryotic & Eukaryotic based products (fermented meats, milk products , yoghurt, cheese, cereal, wine, beer), Impact of biotechnology on microbial testing of food, current/traditional methodology and new approaches (use of gene probes, RDT, Bioluminescence),

Environmental pollution and their management, concept of Global Warming and Ozone depletion (Ecofarming, Green house effect & acid rain), Waste water treatment, solid waste management, conventional & modern fuels & their environmental impact, Bioremediation, Biodegradation of xenobiotic compounds,
Stem Cell Technology, Human Cloning Ethical issues & risks associated with it, Nano biotechnology:– Introduction to nanoscience, size matter, tools for measuring nanostructure Biosencer development and application, Nanofabrication, Nanotech impact on types of DNA chips & their production, SNP and genome mismatch signals, functional proteomics – RT PCR Human Genome Project , Bioterrorism.

Biostatistics and Bioinformatics

Concept of variables in biological systems. Collection, classification, tabulation graphical and diagrammatic representation of numerical data. Measures of central tendency: mean, median and mode and their relationship, measures of dispersion: Range, quartile deviation, mean deviation, standard deviation, Probability, Chi-square (X2), student's t and f-distributions, Analysis of variance: One- way and two-way classifications with single observation per cell.

Definition, role, scope and limitation of Bioinformatics. Different branches of Bioinformatics, Classification of biological database, sequence database: GenBank, EMBLDDBJ, PIR, SWISS-PROT, Structure database: PDB, CSD, CATH, SCOP, FSSP, Specialised Database: KEGG, ENZYME, REBASE. Study odf data entry formats: GenBank, EMBL, DDBJ, Swiss-Port, PIR, PDB, FASTA, MSA, PHYLIP

Sequence Analysis

Nucleic acid sequence analysis: Principle and software tools, Methods of alignment: Dot matrix, Dynamic Programming, Heuristic algorithm (FASTA & BLAST).

Enzyme Technology

Enzyme nomenclature, enzyme commission numbers, and classification of enzymes. Isolation and purification of enzymes, preparation of purification chart, Enzyme activity, Specific activity and turn over number, Marker enzymes, Michaelis and Menten Equation and its derivation, Factors affecting Enzyme activity, coenzyme and cofactors, Stucture and function of Lysozyme, chymotrypsin, DNA polymerase, RNase, proteases, Allosteric enzymes and isozymes

Molecular Genetics

History, Scope of genetics, Mendelian law of inheritance, Variations of mendelian analysis, Linkage and crossing over, Linkage mapping, Sex determination and Sex linked inheritance, gene transfer mechanism in microbe transformation, transduction, conjugation and recombination, Horizontal gene transfer, Types of mutation, molecular mechanism of mutation, chromosomal mutations changes-changes in the structure and number of chromosomes, polyploidy, types of DNA repair, Classical concept, fine structure of gene, molecular concept of the gene, transposons, Pseudo genes, overlapping gene, oncogene, tumor suppressor genes, molecular basis of cancer, Lytic and Lysogenic cycles, IS, and Tn elements in bacteria