

Syllabus of Pre-Ph.D.

Entrance Test

BIOTECHNOLOGY

**MAGADH UNIVERSITY,
BODH GAYA -824234**

Syllabus for Pre Ph.D. Registration Test

Biotechnology

COURSES

I. Cell Biology and Biomolecules

1. Cell theory
2. Plasma membrane, cell wall, their structural organization, membrane associated receptors, Artificial membranes (Liposomes)
3. Membrane proteins and principles of membrane organization
4. Cell organelle & Secretion - Golgi complex, Endoplasmic reticulum, Lysosomes, Peroxisomes
5. Cellular energy transactions - Role of Mitochondria and Chloroplast, Synthesis of ATP
6. Cell cycle- molecular events and model systems
7. Biology of cancer
8. Regeneration
9. Principles of thermodynamics
10. Amino Acids and peptides Structure & Classification, Chemical reactions and physical properties.
11. **Carbohydrates:** Structure & Classification. Mono, Oligo & Polysaccharide, (reducing, Non-reducing sugars, Starch, glycogen pectic substances & cellulose) glycoside linkages
12. **Lipids:** Fatty acids, glycerol, waxes, phospholipids, sphingolipids. Sterols, lipoprotein.
13. **Proteins:** General properties, Classification & separation, purification & criteria of homogeneity, end groups analysis, hierarchy in structure &

Ramachandran map, degradation products, Synthesis of peptides & their application, Boc-chemistry, moc-chemistry.

14. Separation techniques for different biomolecules.

15. Analytical techniques in biochemistry & biophysics for small molecules & macromolecules for quantisation.

II. Microbial Physiology and Genetics.

- 1. Methods in Microbiology:** Pure culture techniques: the theory and practice of sterilization, principles of microbial nutrition, Construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.
- 2. Microbial Diseases:** Disease reservoirs, epidemiological terminologies, infectious disease transmission, respiratory infections caused by bacteria and viruses, tuberculosis, sexually transmitted diseases including AIDS, diseases transmitted by animals (rabies, plague), insects and ticks (rickettsias. lyme disease, malaria), food and water borne diseases, public health and water quality, pathogenic fungi. emerging and resurgent infectious diseases.
- 3. Host-Parasite Relationships:** Normal microflora of skin, oral cavity, gastrointestinal tract, entry of pathogens into the host, colonization and fact predisposed to infections, types of toxins (Exo, Endo, Entero) and their structure, mode of actions, virulence and pathogenesis.
- 4. Chemotherapy Antibiotics:** Antimicrobial agents, sulfa drugs, Antibiotics, penicillins and cephalosporins, broad-spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics, mode of actions, resistance to antibiotics strain.

5. **Bacterial Genetic System:** Transformation, conjugation, transduction, recombination, plasmids and transposing, bacterial genetics map with reference to E. Coli.
6. Viruses and their Genetic System : Phage and its life cycle. RNA phages, RNA viruses, retroviruses.
7. Mendelism and its significance, backcross and testcross.
8. Linkage and Linkage groups, gene mapping, 2-point and 3-point tests.
9. Chromosome Theory of Heredity, Sex-linked inheritance.
10. Interaction of genes, modification of Mendelian ratios.
11. Mechanism of Sex determination in plants and animals.
12. Polyploidy and aneuploidy.

III. Biochemistry

1. **Glycolysis:** Reactions and formation of Pyruvate, Entry of Fructose, Galactose and Glycogen into glycolysis Conversion of Pyruvate into ethanol, lactate or acetyl CoA.
2. **Electron Transport and Oxidative Phosphorylation:** Energy yield by complete oxidation of glucose.
3. **Photosynthesis:** its importance, photosynthetic sites, pigments and units. Absorption of light energy, action and absorption spectra, the two photosystems and their components.
4. **Oxidation of Fatty Acids:** digestion. mobilisation and transport of fatty acid. mobilisation of stored triglycerids by hormones, activation of fatty acids and transport to mitochondria. oxidation of saturated fatty acids, oxidation of unsaturated fatty acids and oxidation of odd chain fatty acids, over production of ketone bodies.
5. **Biosynthesis of fatty acids:** Formation of malonyl CoA fatty acid synthase complex and its reactions, shuttling of acetate out of mitochondria

as citrate, regulation of fatty acid biosynthesis. Biosynthesis of triglyceroles, membrane phospholipids and prostaglandins.

IV. Molecular Biology and Genetic Engineering

1. Protein synthesis an overview, Central dogma
 - (a) Transcription in Pro and Eukaryotes, RNA editing and removal of intron by RNA splicing (spliceosome).
 - (b) Translation- Polypeptide chain initiation, elongation and termination post translational changes.
2. DNA replication in pro and eukaryotes - features in vivo and nature, replicons and multiple replicons, replication apparatus, primosomes and replisomes, replication forks (Cairn's experiment), bidirectional replication in E. Coli.
3. Molecular tools and their applications: Restriction enzymes, modifications enzymes, DNA and RNA markers.
4. Nucleic acid purification, yield analysis.
5. Nucleic acid amplification and its applications.
6. Gene cloning vectors: Plasmids, bacteriophages, phagemids, cosmids, Bacterial artificial chromosomes, (BACS).
7. Restriction mapping of DNA fragments and map construction, nucleic acid sequencing.
8. cDNA synthesis and cloning : mRNA enrichment, reverse transcription, cDNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening.
9. **Gene therapy:** Vector engineering, Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.
10. Isolation of Plasmids

V. Immunology

1. **The Immune System:** Innate and adaptive immunity, organs involved in immune response, primary and secondary lymphoid organs. cells involved in the immune response, lymphocyte traffic.
2. **The Immunogenic Molecule:** Structure and function of Ig molecule, sequence analysis. function of heavy and light chains, antigen binding and effect on functions, Antigenic determinants of Ig molecule, structure of various isotypes, generation of antibody diversity. V-J and V-D-J rearrangements in Ig genes. the Ig super gene family.
3. **Monoclonal Antibody and Hybridoma Technology:** Generation of monoclonal antibodies by hybridoma technology and genetic engineering, their use in immunology, molecular biology. biochemistry and biotechnology. Advantages over polyclonal antibodies.
4. **Major Histocompatible Complex:** Organisation of MHC genes, interaction of gene products with other cells, MHC class I and class II molecules, functions, polymorphism. Haplotypes, probing for various WIC molecules, susceptibility to diseases, restriction.
5. **T Cell Receptor (TCR):** Structure, function and generation of diversity in T cell receptor molecules. TCR- peptide-MHC interactions. Super antigens
6. **Antigens Presentation:** Processing and association of antigenic fragments with MHC class I and class II molecules.
7. **Cytokines:** Structure and their receptors, cloning and expression of Cytokine genes, Signal transduction by cytokine receptor and modulation of immune response. Cytokine Profile in diseases, cytokine therapy.
8. **Complementary System:** Complement molecules and activation of complement system, classical and alternative pathways, consequences of activation and diseases.

9. Hypersensitive Reactions: Type I (Ig E). Type II (Ig mediated). Type III (Immune complex mediated). Type IV (cell mediated), DTH and protective response.
10. Auto Immune Response and Disease: Auto immune disease in humans and animals, therapy and prevention. MHC and T cells in auto immune response.
11. Brief introduction to the life cycle and molecular biology of some important pathogens of **AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar.**

VI. Macromolecules & Basic Enzymology

1. Enzymes

- (a) General Characteristics, Nomenclature and Classification.
 - (b) Chemical nature — apoenzymes and coenzymes
 - (c) Mode of action. Energy considerations. Enzyme Kinetics. Michaelis Menten equation.
 - (d) Properties and factors affecting enzyme action), inhibition and activation of enzymes.
 - (e) Acid-Base catalysis and other mechanism of catalysis.
 - (f) Constitutive and inducible enzymes. Isozymes-3
 - (g) Allosteric enzymes and regulation.
2. Enzymes Allosteric enzyme, kinetics of enzyme inhibitors.
- (h) Enzymes Immobilization: Methods of immobilization, covalent bonding to support physical absorption and entrapment, effects of immobilization on enzyme characteristics, analytical industrial and therapeutic uses of immobilized enzymes.
3. Fermentor design: Basic functions offer mentor, aseptic operation, body construction, aeration and agitation other fermentation vessels.
4. Downstream processing.

5. Industrial production of chemicals ; Alcohol (ethanol), acids (citric, acetic, gluconic), Solvents (glycerol, acetone and butanol), antibiotics (Penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid), Single cell protein.

VII. Animal and Plant Biotechnology :

- 1. Introduction to animal biotechnology:** Vaccines, immunoneutralization, transgenic, production of recombinant vaccines using mammalian tissue cultures.
- 2. Animal cell cultures:** Growth medium and brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Measuring growth parameters. Basic techniques of mammalian cell cultures in vitro. Cell synchronization and cell transformation. Application of animal cell culture.
- 3. Vaccine production by recombinant DNA technology:** Selection of target antigens for vaccine development, Identification and cloning of genes for target antigens. Expression of target antigens in prokaryotes and eukaryotic hosts. Construction of chimeric proteins as target antigens. Conjugation of target antigens with antigen carrier molecules to improve immunogenicity. Immunoprophylaxis by live attenuated recombinant viruses, attenuated vaccinia virus and adenovirus as vectors heterologous target antigens.
- 4. Application of nucleic acid hybridization to diagnosis of microbial infections and to genotype analysis.**
- 5. The micro manipulation of farm animal embryos:** Anatomy and physiology of embryos in relation to micromanipulation, Instrumentation, culture methods, combining embryo cells, intracellular manipulations and conservation of manipulated embryos.
- 6. Application of Biotechnology in animal breeding strategies.**

VIII. Environmental Biotechnology

- (a) Biogeochemical cycle: Carbon, nitrogen and sulfur cycle
- (b) **Biomonitoring:** Biomonitoring of water quality (physical, chemical and biological), Role of microbes in biomonitoring of water quality, indicator organisms, biosensors.
- (c) Wastewater treatment methods-Trickling filter-microbial community, design, operation, Activated sludge-microbial community, design, operation; treatment of solid wastes, Anaerobic treatment of wastewater and sludge.
- (d) **Bioremediation:** Treatment of industrial effluents (pesticides and toxic chemicals). biodegradation, bioremediation, bioaugmentation: oil spillage and degradation of hydrocarbons
- (e) Biofuels:
- ❖ Brief idea about renewable and non-renewable energy resources
 - ❖ Conversion of domestic and agro-wastes into ethanol
 - ❖ Methanogenesis and biogas production
 - ❖ Plant based fuel (biodiesel etc.)
 - ❖ Hydrogen as fuel and its microbial production.
- (f) **Biofertilizer:** Introduction, types and application: Characteristics, mass cultivation and quality control.
- (1) Nitrogen fixers: Rhizobium Azospirillum. Azotobacter and cyanobacteria.
A Zolium Anabaena, azolla association.
- (2) Phosphate solubilizers: Mycorrhiza
- (g) Biological control of Insects: Bacterial, viral and fungal pesticides
- (h) Microbial mining: Microbial enhanced recovery of mineral resources: Use of microbes in oil recovery.