

Appendix I

SYLLABUS FOR CHANGE OF DISCIPLINE

(M.Sc Biotechnology)

Chemistry

- Principle of thermodynamics, thermodynamics of ideal solutions
- Chemical Bonding and Molecular Structure: Ionic and Covalent
- Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms).
- Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.
- pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).
- Role of metal ions present in biological systems with special reference to Na⁺, K⁺ and Mg²⁺ ions:
- Surface tension. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer.
- concept of reaction rates. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

BIOCHEMISTRY

- Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Conformation of nucleic acids [helix (A, B, Z), t-RNA, micro-RNA].
- Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
- Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
- Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids

Plant Physiology and Metabolism

- Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.
- Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.
- Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
- Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.
- Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C₃, C₄ and CAM pathways of carbon fixation; Photorespiration.
- Biological nitrogen fixation; Nitrate and ammonia assimilation.
- Algae: General character, classification and economic importance
- Fungi: General characters, classification & economic importance.
- Lichens: Classification, general structure, reproduction and economic importance.
- Bryophytes: General characters, classification & economic importance.
- Plant diversity: General characteristics, classification Identification.
- Causal organism, symptoms and control of following plant diseases. Rust & Smut of Wheat.

ANIMAL DIVERSITY

- Outline of classification of non- Chordates upto subclasses. Coelomata, Acoelomata
- General characters, outline of Classification: Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca , Echinodermata, Hemichordata.
- General features, Classification and important characters of Proto-chordates, Pisces and Amphibia
- General features Classification, Origin: Reptilia, Aves and Mammalia
- Mammalian Anatomy & Physiology

CELL BIOLOGY

- Cell: Introduction and classification of organisms by cell structure, cytosol,
- Compartmentalization of eukaryotic cells, cell fractionation.
- Cell Membrane and Permeability: Chemical components of biological membranes,

organization and Fluid Mosaic Model, membrane as a dynamic entity,

- Cell recognition and membrane transport,
- Cell wall Ultrastructure & Function.
- Membrane Vacuolar system,
- Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.
- Endoplasmic reticulum: Structure, function including role in protein segregation.
- Golgi complex: Structure, biogenesis and functions including role in protein secretion.
- Lysosomes: Vacuoles and micro bodies: Structure and functions
- Ribosomes: Structures and function including role in protein synthesis.
- Mitochondria: Structure and function, Genomes, biogenesis.
- Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.
- Cell cycle: Mitosis & Meiosis

GENETICS

- Overview of Mendelian genetics, its modifications, Sex determination and linkage
- Chromosomal structure, Linkage and crossing over
- Gene mutations
- Human genetics: Eugenics, Pedigree construction and analysis (Inheritance pattern of sex linked, autosomal dominant and recessive traits), Inheritance of human traits- Brown eyes, polydactyl, Diabetes insipidus, sickle cell, anaemia. Study of various human chromosomal disorders

MOLECULAR BIOLOGY

- DNA structure and replication
- DNA damage, repair and homologous recombination
- Transcription and RNA processing.
- Translation and Regulation

Recombinant DNA technology

- Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase.
- Gene Recombination and Gene transfer: Transformation, episomes,
- Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes),
- Microinjection, Electroporation, Ultrasonication,
- Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.
- Restriction and modification system, restriction mapping.

GENERAL MICROBIOLOGY

- Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.
- Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells,
- Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.
- Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.
- Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.
- Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways
- Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.
- Control of Microorganisms: By physical, chemical and chemotherapeutic Agents
- Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.
- Food Microbiology: Important microorganism in food Microbiology: Molds, Yeasts, bacteria

BIOPROCESS TECHNOLOGY

- Basic principle components of fermentation technology.
- Types of microbial Culture and its growth kinetics– Batch, Fedbatch and Continuous culture.
- Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes.
- Principles of upstream processing – Media preparation, Inoculum development and sterilization.

IMMUNOLOGY

- Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies,
- Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors.
- Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.

PLANT BIOTECHNOLOGY

- Plant tissue culture. In vitro culture techniques: Sterilization methods,
- Culture media – composition, types of media and role of hormones in in-vitro culture. Inoculation, Incubation and Acclimatization. Cryo and organogenic differentiation,
- Types of culture. Protoplast culture technology.
- Plant transformation using *Agrobacterium tumefaciens*,
- Production of secondary metabolites using plant tissue culture
- Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Growth promotion by free-living bacteria.
- Applications of Plant Biotechnology-Improved crop varieties- High yield, Insect resistance, drought and salt tolerance, edible vaccines

BIOSTATISTICS AND BIOINFORMATICS

- Types of Data, Collection of data; Primary & Secondary data,
- Classification and Graphical representation of Statistical data.
- Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.
- Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

ANIMAL BIOTECHNOLOGY

- Requirements for animal cell culture technology.
- Culturing of cells, Cell growth (cell cycle, synchronization, apoptosis)
- Gene transfer methods in Animals Introduction to transgenesis. Transgenic animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.
- Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.
- Genetic modification in Medicine - gene therapy, types of gene therapy

ENVIRONMENTAL BIOTECHNOLOGY

- Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.
- Environmental pollution - types, sources, measurement, methods of measurement of pollution, fate of pollutants in the environment,
- Bioconcentration, bio/geomagnification.

Analytical Tools

- Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), absorption and emission spectroscopy.
- Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation: principle of centrifugation, centrifugal force and sedimentation rate, differential and density gradient centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.
- Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.
- Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Southern Blotting, Northern Blotting and Western blotting.