

# Detailed syllabus for two year M.Sc. course in Microbiology

## SEMESTER I

CREDIT-18

### A] Biophysical chemistry and Instrumentation -I (25)

**Spectroscopy:** Principles of Light absorption, extinction coefficient, uv-visible and quantitative analysis of analytes, Infrared Spectroscopy, molecular vibrations, normal modes and group vibrations. molecular vibrations, normal modes and group vibrations – hydrogen bonding effect on vibrational spectra, IR and UV spectral analysis of biomolecules, ultraviolet, visible and infra-red absorption spectrophotometer and their working principles.

fluorescence and phosphorescence.

[SRC]

### Physical Principles and Reaction Kinetics in life processes

Kinetics of reaction, activation energy, Kinetics and mechanistic study of molecules, determination of rate of processes and order of reactions, temperature dependence, Polar molecules, molar refraction and polarization, dipole moment; vander Waals Forces, determination of pK's of amino acids. Free energy of charged macro ions; Debye-Huckel theory; Hydration, solvation number.

[SRC]

**Microscopy:** Basic idea of light, dark and phase contrast microscopy, Chromatic and spherical aberration, Recent developments in electron microscopy

Atomic force microscope- their construction and basic principles. Specimen preparation techniques, applications of EM in cell biology and molecular biology. microspectrophotometry of cells & tissues; fluorescence activated cell sorter (FACS), Confocal microscopy [SSC]

**Physicochemical techniques:** Liquid Scintillation Counter; pH meter, Ultracentrifuges; microspectrophotometry of cells & tissues; fluorescence activated cell sorter (FACS).

**References:** Cantor and Shimmel, Van Holde, David Freidfelder, Lakowicz, Nakamooto-Principles of Raman Spectroscopy

### B] Biological macromolecules: (30)

CREDIT 5

**Amino acids and peptides:** Structure of amino acids, Chemical reactions and modification, physical properties, sequencing, synthesis of peptides. Proteins: End group analysis, Sequencing, Purification

**Protein structure:** Hierarchy of structure, primary, secondary, tertiary and quaternary, torsion angle and Ramachandran plot, motifs and domains

**Forces stabilizing protein structure:** H-bond, Electrostatic interaction, Hydrophobic interaction, Vander Waal's interaction

**Structure function relationship of proteins :** fibrous proteins (keratins and collagen), globular protein (oxygen transport proteins hemoglobin and myoglobin)

**Protein folding and chaperones:** Protein splicing, unfolding of protein structure, effect of heat, pH and chemicals, denaturation and refolding of proteins, in vivo protein folding, concept of chaperones, disease related to protein misfolding. [KS]

**Crystallography:** Crystals, definition, growing crystals, conditions for macromolecular crystallization, theories of x-ray diffraction, Bragg's law, determining the crystal morphology, solving macromolecular structure by x-ray diffraction.

**Nucleic acid:** Types and basic structure (DNA, RNA), Principles of sequencing and oligonucleotide synthesis. Double helical structure of DNA(Watson-Crick model), Sugar puckering and base stacking; B-A- and Z-DNA, other nonperiodic structures (DNA bending, Supercoiling) and their significance. Denaturation kinetics of DNA, Cot curves. Nucleic acid hybridization its application. Folding of RNA into higher order structures (mRNA, tRNA, rRNA in ribosome), modified nucleotides in tRNA and rRNA and their importance, Purification and separation of nucleic acids.

**Lipids:** Classification, Structure-function, role in biological membranes. Lipoproteins

**Carbohydrates:** Classification and reactions. Polysaccharides: Types, Structural features, determination of composition. Glycoproteins

**References:** Adams, Voet and Voet, Van Holde, Stryer, Lehninger, Benjamin and Lewin.

## C] Cell biology and cell signalling

(50)

CREDIT-4.0

### **Cell membrane and cell wall:**

Constitution of cell membrane, membrane proteins and lipids, ultra-structure of cell membrane (both prokaryotic & eukaryotic), fluid mosaic model, asymmetry in membrane, domains in membrane- natural & artificial membranes, **liposomes**, modern methods for the study of cell membranes- FRAP, scanning calorimetry, PAS reaction, Enhanced Chemiluminescence (ECL), freeze-etching, freeze-fracturing. Hydrophobicity plot, Structure, function, diversity, synthesis and cell wall hydrolyzing enzymes of bacteria and fungus [AKM+SSC]

### **Intra Cellular Compartments & Protein Sorting:**

The compartmentalization of cells, the transport of molecules between the Nucleus & the Cytosol, Transport of Proteins into Mitochondria & Chloroplasts, Peroxisomes, the Endoplasmic Reticulum. Methods of studying the Cell Surface, Reconstitution studies, Fluorescence Assisted methods e.g: Flow Cytometry, Membrane Active Peptides, Membrane Cytoskeleton, Membrane Anchorage of Proteins, Vesicular Traffic in the Secretary & Endocytic Pathway, Transport from ER through the Golgi Apparatus, Transport from the Trans Golgi network & maintenance of Compartmental Diversity. [SSC]

**Quorum sensing in bacteria-** Role of acyl homolactone serine in quorum sensing in bacteria, types of quorum sensing, regulation of quorum sensing, cell signaling in myxobacteria. [MMG]

**Cell cycle:**

General strategies of the cell cycle; molecular mechanism of cell-cycle control; [AKM]

**Cellular structure and function:**

Flagella, Pili, Capsules, Cell wall synthesis, Genetics of flagellar movement, two-component system, receptor methylation etc.

Spores of bacteria., introduction to mycoplasma, Biology of gliding bacteria , classification of proteobacteria, fruting body formation in myxobacteria [AKM]

**Cell signaling:**

Principles of cell signaling, extra cellular signals: hormones, cytokines and growth factors, different types of receptors : G protein linked, ion channel linked, Enzyme linked receptors, receptors containing intrinsic enzymatic activity, tyrosine kinase receptor, intracellular receptors of extracellular signals, Protein phosphorylation, kinases, phosphatase: serine threonine kinase, tyrosine kinase, MAP kinase with special relevance to yeast mating and glycerol synthesis, histidine kinase activity in bacterial chemotaxis, serine, threonine and tyrosine phosphatase, cyclic nucleotides, lipid signaling: inositol phospholipids pathway, NO signaling, molecular mechanism of apoptosis.

**References** - Molecular biology of cell- Bruce Alberts, Cell Biology – Karp, Cell signaling by John T Hancock (Oxford), Darnell, Prescott, Stanier.

**D] Taxonomy, Morphology and Ecology (35)**

**CREDIT-4.0**

**Taxonomy:** Taxonomic principles, Taxonomic hierarchy, structure, alpha taxonomy and omega taxonomy, Microbial and plant classification, classification types. Numerical taxonomy and chemotaxonomy, Bergey's Manual of Determinative Bacteriology.

General characteristics of various groups of prokaryotes: Archaeobacteria, eubacteria ,mycoplasmas, rickettsiae, chlamydiae, spirochaetes, cyanobacteria, actinomycetes.

**Morphology:** Morphological features of algae, fungi, bryophyte and pteridophyte and their evolution. Economic importance of these members.

Anatomy and morphology of gymnosperms and angiosperms, brief idea of their development and morphogenesis. [AKM]

**Ecology:** Interaction between abiotic and biotic factors in an ecosystem, ecological niche, limiting factor, concept of community, fluctuation and succession.

Ecological pyramid, energy flow, food chain, food webs and their dynamism, stability and complexity of ecosystem, bio geo chemical cycles, conservation and sustainable development, environmental impact assessment. [DS]

**E] Enzymes****(30)****CREDIT 5.5**

Enzymes: General Features (outline only)

**Enzyme kinetics-** Thermodynamics of enzyme kinetics. Michaelis –Menten equation including derivation, Graphical representation—Lineweaver –Burk Plot, Eadie-Hoffstee plot, two substrate kinetics--single and double displacement reaction (Ping-pong Bi-Bi reaction). three substrate kinetics, deviation from linear kinetics, rapid kinetics. Ligand binding studies(Hill's equation). Use of isotopes in enzyme kinetics mechanism analysis.

Enzyme inhibition-

a) Reversible inhibition-----Competitive ,Non-competitive and Uncompetitive Inhibition and their examples and biomedical implications

b) Irreversible inhibition----enzyme modification

Regulation of enzyme: Covalent and acid base catalysis

Regulatory enzymes- Allosteric enzyme and covalent modulation,Feedback inhibition, Ribozyme (catalytic RNA), Abzyme and Isozyme, Active site determination studies.

Industrial application of several enzymes.

[US]

**PRACTICAL (Total 80)**  
**CREDIT-6**

**Introductory Microbiology: (15)** Basic techniques

**Biochemistry (20+20+15)**

**A. Chemical analysis of biomolecules:**

**HPLC analysis**

**Quantitative test** of protein by Bradford method, Estimations of blood glucose, free fatty acids, cholesterol and proteins, Study of disease development in plant and its multicomponent resistance mechanism through phytoalexin or phytoanticipin production

**Enzymology**

**Assay of Enzymes-** Extraction of enzymes from natural sources (Microbial, plant and animal) and its characterization including determination of  $K_m$  and pH optima.

**B. Biochemical & Biophysical Techniques**

Paper chromatography of carbohydrates, use of inhibitors for active site determination, chromatographic techniques, purification of enzymes, chemical estimation of vitamins, minerals like  $Ca^{+2}$ ,  $Fe^{+2}$ , determination of molecular weight by gel filtration.

Techniques for purifying and characterizing Proteins and Enzymes, Idea of all analytical techniques like Electrophoresis, Liquid Chromatography, Column Chromatography for enzyme protein analysis.

## Semester 2

## CREDIT-

### A] Biophysical Chemistry and Instrumentation II (25)

**Spectroscopy:** Nuclear magnetic resonance; principles behind splitting, spin-spin interaction, spin-lattice interactions, Nuclear Overhauser Effect, nuclear quadrupole effects, spectral interpretations; Electron Spin Resonance (ESR), Zero Field Splitting, Use of standards, Calculations of coupling constants, Mass spectrometry, Fragmentations patterns in biomolecules and advancement in biological applications, Raman spectroscopy and its biological applications; circular dichroism (CD) and optical-rotatory dispersion (ORD) and their application in the study of macromolecules.

[SRC]

**Thermodynamics: (outline only if needed elaboration may be done as mentioned here)** Extensive and intensive variables; mathematical description of a system with two or more variables, exact and partial differential; first law of thermodynamics, Second Law of Thermodynamics, isothermal process, free energy and chemical potential; Gibb's free energy, osmotic pressure, Donnan equilibrium, coupled reactions.

### B] General and Microbial metabolism (40)

**Pathways of Glucose degradation :** Glucose Metabolism – Embden- Meyerhof-Parnas (EMP) pathway, Warburg-Dickens or hexose monophosphate (HMP) pathways, Entner-Doudoroff (ED) pathway, Phosphoketolase (PK) pathway, TCA cycle, gluconeogenesis, Cori cycle, Glycogen metabolism.

**Oxidative phosphorylation :** Aerobic respiration in mitochondria (electron transport, oxidative phosphorylation, regulation of ATP production); Anaerobic respiration and fermentation.

**Bacterial Bioenergetics:** Basic mechanism of ATP synthesis, Reverse and forward electron flow. Chemolithotrophic bacteria- Different types namely ammonia oxidizers, nitrite oxidizers, hydrogen oxidizers, iron oxidizers and Sulphur oxidizers. General transport and photosynthesis.

**Metabolism of Amino acids proteins and Nucleic acids :** protein turnover; flow of nitrogen into biosynthesis and catabolism of amino acids (with reference to representative examples phenylalanine, tyrosine, tryptophan, arginine, alanine, glycine, glutamic acid, glutamine); central role of glutamine; metabolism of nucleotides (purines and pyrimidines); urea cycle and the excretion of nitrogen.

**Fatty acid Metabolism:** Oxidation of fatty acids,  $\beta$  oxidation; biosynthesis of fatty acids and cholesterol (outline); ketone bodies. Integration of metabolism and metabolic regulation with reference to metabolic pool.

**Metabolism of energy reserve compounds:** Polyglycans, Poly- and  $\beta$ -hydroxybutyrate, nitrogenous and non nitrogenous compounds- their synthesis and degradation in bacterial cells.

**Reference:** Voet and Voet, L. Stryer, H.W Dolle, Nelson & Cox.

**C] Molecular Biology [SSC+MMG+NG] (50)**

**DNA replication:** (Outline only) (prokaryotic – *E. coli* chromosome) plectonemic and solenoidal supercoiling; rolling circle mode of replication; asymmetric replication – looped rolling circle -  $\phi$ X174 and M-13 bacteriophages; concatemer formation -  $\lambda$  bacteriophage. Eukaryotic replication

**DNA repair and recombination:** (Outline only) Photoreactivation, excision, recombination, mismatch, SOS, Holliday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination, RecA and other recombinases.

**Transcription:** (Outline only) (Prokaryotic); lac-operon, Trp operon, Ara operon, Gal Operon

**Eukaryotic Genome:** Structure of Chromatin, Chromosome, Centromere, Telomere, Nucleosome, genome organization, chromatin remodeling; types of histones, histone modifications-methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence, Law of DNA constancy, C value paradox and Genome size, Karyotype and Idiogram, chromosome banding pattern, types of chromosomes, Giant chromosomes-polytene and lampbrush chromosome, multigene families, population genetics (outlines and problems).

**Eukaryotic gene transcription and its regulation:** Promoters, enhancers, transcription factors and regulation of their activities, RNA Polymerases, different structural motifs in DNA binding proteins involved in transcription.

Molecular mechanisms of transcription activation and repression: Gene silencing, Histone deacetylation and hyperacetylation and chromatin remodeling in transcription control, Activator/Coactivator interaction, regulation of transcription factor activity, Control at the stages of elongation and termination.

**Post-transcriptional gene control and Nuclear transport:** RNA processing enzymes, post transcriptional modification of RNA: 5'-cap, 3' end processing and polyadenylation. RNA Splicing, Editing, regulation of pre-mRNA processing, Different modes of splicing of mRNA and tRNA, Nuclear export of mRNA Cytoplasmic mechanisms of post-transcriptional control, snRNPs.

**Translation:** (prokaryotic) Genetic code, Initiation, Elongation, Termination, Post-termination steps, Involvement of different cofactors in translation, Translational fidelity. ribonuclease inhibitors, DNA sequencing, construction and screening of cDNA library (outline), principles of PCR (outline).

**Eukaryotic translation** and its control; Post-translational processing.

**References:** Weaver, Watson, Freifelder, Benjamin Lewin , Russel.

**D] Environmental Microbiology: Credit 5 (25)**

**Biology of hydrosphere:** The aquatic environment - major environmental conditions influencing microflora. Distribution of microorganisms in the aquatic environments - freshwater environment, estuaries and marine environment. Microbiology of drinking water-pollution, purification of water for human consumption. Assessment of microbial status in water and waste water. Biomonitoring of harmful microorganisms in water. Wastewater characteristics, treatment processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection). [FX]

**Biology of lithosphere:** Soil as a habitat for microorganisms, methods of studying microorganisms and their activities in soil. Increasing soil fertility by chemical and bio fertilizer. Biology and biochemistry of N<sub>2</sub>-fixation, Biochemical transformation of inorganic and organic nitrogen compounds. Microbial degradation of cellulose, hemicelluloses, lignin, xylans, starch and pectin. Biodegradation of petroleum hydrocarbons, pesticides, herbicides and xenobiotics, Bioremediation: Metal-microbe interactions, Microbial control of pollution by microbes POPs and heavy metals [MMG]

**Biology of atmosphere:** Source and kinds of microorganisms present in the atmosphere, techniques for microbiological sampling of air. Air-borne disease and their control.[DD]

**Agricultural Biology:** Rhizosphere and phyllosphere micro organisms and their interactions with plants. Plant pathogen (bacterial and fungal) Mechanisms of plant pathogenicity, symptoms of plant diseases, transmission of plant diseases. Signalling events in pathogenesis and resistance to pathogens. Molecular basis of plant disease control along with cultural practices, chemical control and biological control. Microbial control of insects. Beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungus). Biopesticides and biocontrol agents. SAR and ISR. Integrated Pest Management. Critical Review from recent papers.[AKM]

**References:** An introduction to Microbiology- Brock., Stanier

**E] Plant physiology, plant breeding and tissue culture and Plant Biotechnology: [AKM] (30)**

Water relations, mineral nutrition, nitrogen, phosphorus and sulphur metabolism, stomatal physiology, source and sink relationship, physiology and biochemistry of seed dormancy and germination, hormonal regulation of growth and development. Photoregulation, growth responses, physiology of flowering, senescence.

Plant breeding principles, important conventional methods of breeding of self and cross pollinated and vegetatively propagated crops. Non conventional methods, mutation breeding. Tissue culture: Basic techniques, culture media, shoot and root tip culture and somatic embryogenesis.

**Photochemistry:** Chlorophyll excitation, singlet level and triplet state, fluorescence, phosphorescence

**Photosynthesis in higher plants** chloroplast (Calvin cycle,C4 cycle,C3 cycle

**Bacterial Photosynthesis:** Photopigments, Different types of photosynthetic bacteria- Cyanobacteria, Green and Purple Bacteria, paths of carbon assimilation and electron flow in bacterial photosynthesis, Classification of bacteria on nutritional basis.

**Plant Biotechnology** [AKM]

Genetic engineering of plants: Transformation of plants, manipulating gene expression in plants, selectable markers and reporter genes, *Agrobacterium tumefaciens*; Genetic elements present on the Ti plasmid, genetic engineering of Ti plasmid, vectors used to introduce foreign DNA into plant cells-binary cloning vector, disarmed Ti plasmid, Cointegrate cloning vector, comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes. Special features of plants; Micropropagation; Plant cell culture; Haploid culture and regeneration; *Agrobacterium* and genetic engineering in plants. Ti and Ri plasmids. Binary vectors, plant viruses as vectors; Specific promoters for plant; Light regulated *cis* elements; Incorporation of T-DNA into nuclear DNA of plant cells and transformation strategies.

**Practical****(80)****Credit-6**

**A. Plant Tissue Culture: (40)** Preparation of culture media, explants and its expression, callus and suspension culture, Demonstration of electroporation (**Bose Institute**)

**B. Environmental biology: (40)**

Determination of MPN, BOD, COD & DO of water,

Isolation of free living nitrogen fixers from soil,

Measurement of microbial activity in soil by soil respiration method,. Isolation of phosphate solubilizing and cellulose degrading bacteria, soil enzyme assay

Effect of temperature & pH on microbial growth, techniques for cultivation of anaerobic bacteria.

## Semester 3

## CREDIT-

### A] Recombinant DNA technology and Gene therapy (40)

Points 1to5 Revision of B.Sc syllabus outlines only.

1. Techniques used in RDT – agarose gel electrophoresis, labeling of DNA, DNA-DNA- RNA Hybridization - Northern, Southern, PCR, (different types) RFLP, DNase foot-printing; Site-directed mutagenesis; DNA sequencing (Alternatives to Sanger sequencing); Western, Immuno-precipitation;
2. Enzymes used in RDT – names, functions and uses;
3. Basic strategy of Cloning – vectors ( lambda gt10, gt11 Bacteriophage lambda replacement vectors, phage P1 vector, BACs, PACs, DNA cloning with single stranded DNA vectors, (M13 vectors), Cosmids, Phasmids and other advanced vectors, specialist purpose vectors for amplification and for expression (pETvector, pBAD vector), Gateway cloning system
4. Construction of cDNA and genomic DNA library (Full length cDNA cloning by rapid amplification of cDNA ends
5. Different screening techniques – antibiotic resistance, blue-white screening, hybridization, immuno-screening
6. a) Cloning in gram positive and gram negative bacteria  
b) Cloning in Eukaryotes: Yeast: *Saccharomyces cerevisiae* and *Pichia pastoris*
7. Gene transfer to animal cells: a) transfection by Calcium phosphate, Lipofection, Electroporation, Transduction by baculovirus, Adenovirus and Lentivirus  
b) selectable markers for gene transfer in animal cells,
8. Genetic manipulation in animals: By ES cells

**References:** Principles of Gene Manipulation and genomics: S.B. Primrose and R.M. Twyman, Molecular Biology: Weaver, Russel –i-genetics, Recombinant DNA :Watson, Gene analysis: T. A. Brown. Molecular Biology :Clark, Molecular and cell biology: Baltimore, Lodish III edition

### Gene therapy: [US/MMG]

Background, Basic process, Types of gene therapy: Germ line gene therapy, Somatic cell gene therapy, Broad methods, Vectors in gene therapy, Viruses: Retroviruses, Adenoviruses, Adeno-associated viruses. Envelope protein pseudotyping of viral vectors, non-viral methods; naked DNA, Oligonucleotides, Lipoplexes and polyplexes, Hybrid methods, Dendrimers, Major developments in gene therapy from 2002 to 2007, Problems and ethics

### B] Genomics and Proteomics and Bioinformatics

(40)

#### Genomics

What is genome, genome complexity, mapping and sequencing genomes (RFLP, SNP, AFLP, HT sequencing by shotgun sequencing and physical mapping, analysis of the transcriptome – DNA microarray, application

## **Proteomics:**

What is proteome, nature of proteome, overview of the tools to study proteome, two-dimensional gel electrophoresis (2D-PAGE), Mass Spectrometry (MALDI/MALDI-TOF), Interpretation of Mass Spectra, MS/MS of peptide, Mass-spectrometry search engines: Mascot, structural proteomics – X-ray crystallography, protein-protein interactions, Yeast 2-hybrid, Co-immunopurification/Mass-spectrometry, application, Metabolomics (in brief)

**Reference:** Principles of Gene Manipulation and Genomics: S.B. Primrose and R.M. Twyman

## **Bioinformatics:**

Introduction of genomic data and data organization,. Sequence data bank: introduction to sequence data bank: protein sequence data bank, NBRF-PIR,SWISSPORT, signal peptide data bank, nucleic acid sequence data bank- gene bank, EMBL, nucleotide sequence data bank, AIDS virus sequence data bank, rRNA data bank. Structural data bank : protein data bank (PDB). The Cambridge Structural Data base (CSD). Genome data bank: metabolic pathway data ; microbial and cellular data bank. Introduction to MSDN ( microbial strain data network). Neumerical coding system of microbes. Hybridoma data bank structure. Virus information system, cell line information system. Other important data banks in the area of biotechnology / life sciences/ biodiversity.Sequence analysis – Analysis of Tools for sequence Data Banks. Pair wise alignment- NEEDLEMAN and Wunch algorithm, Smith Waterman. Multiple alignment – CLUSTAL, PRAS; BLAST. FASTA algorithm to analyze sequence data. Sequence pattern, motifs and profiles. Secondary Structure predictions; Prediction Algorithms. Chao-Fasman algorithm,

## **C] Immunology AND Cancer biology [KS]**

**(35)**

Organization and expression of Ig genes; MHC/HLA; T-Cell maturation, activation and differentiation, T-cell-Receptor, Antigen-processing and presentation; B-cell maturation, Activation and differentiation; Cytokines; Hypersensitivity; Autoimmunity, Vaccination, Immune system in health and disease- Transplantation Immunology, immunodeficiencies, cancer and immune system.

**Classification and Nomenclature,** Signs and symptoms

**Causes of cancer:** Chemical carcinogens , Ionizing radiation , Infectious diseases, Hormonal imbalances, Immune system dysfunction, Heredity, Other causes.

**Pathophysiology of cancer:** Epigenetics, \_Oncogenes, Tumor suppressor genes, cell signalling and cancer.

**Cancer cell biology:** Clonal evolution, Biological properties of cancer cell.

**Therapeutics:** Antiangiogenesis, immunotherapy, gene therapy

**Reference:** Kuby, Abbas.

## D) Genetics

(35)

### **Modes of Gene Exchange: Outlines for the first three headings**

**Transformation:** Natural Transformation, Discovery of Transformation, Competence, Uptake of DNA during natural transformation, Mechanism of DNA uptake during transformation, genetic evidence for single stranded uptake, Plasmid transformation and transfection of naturally competent bacteria, Mapping by transformation, Artificially induced competence, Calcium ion induction, Electroporation.[SSC]

**Conjugation:** Interrupted mating and time of entry mapping, linkage mapping, Mechanism of DNA transfer during conjugation in Gram-negative bacteria, Chromosome transfer by plasmids, Genetic mapping with Hfr Crosses, Chromosome mobilization, Prime factors, Transfer systems of Gram positive bacteria, Interrupted mating and time of entry mapping, linkage mapping. [SSC]

**Transduction:** Recombination and complementation tests with phages, Experiments with the rII genes of phage T4, Constructing genetic linkage map of a phage, Generalized transduction, Cotransduction and linkage, Mapping by Cotransduction, Properties of specialized transducing particle, Specialized transducing phage as a cloning vehicle. .[SSC]

**DNA damage and repair:** Factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination and SOS pathways. [DS]

**Mutation:** Mutation, spontaneous and induced, mutagenic agents, Luria-Delbruck fluctuation test; replica plating [NG]

- 1. Microbial recombination models:** Holliday double strand invasion model( *E.coli*); Single strand invasion model; Double strand break repair model(*Saccharomyces cerevisiae*). Molecular mechanism of recombination in *E. coli*; X sites and RecBCD nuclease; RecA protein function; Ruv and RecG proteins and migration and cutting of Holliday junction; RecF pathway. [NG]
- 2. Transposons:** transposable elements in prokaryotes and eukaryotes (yeast, maize and fruitfly). [KS]

### **Genetics and genetic Interaction [AKM]**

Physical basis of heredity; cell division, Mendel's Laws, gametogenesis, life cycle ( Yeast, *C.elegans* ); structure and organization of some special chromosomes like polytene and lambrush chromosome single gene inheritance, terminology, allelic relationship, single gene crosses, pedigree analysis; two or more gene, independent assortments, dihybrid cross, genetic interactions; two factor interaction, epistatic interaction, non epistatic interaction, interaction with three or more factors. Doses compensation and sex determination and sex linked inheritance, Linkage and chromosome mapping: linkage, cross over, chi square test for linkage, recombination frequency and map construction, tetrad analysis in yeast and recombination mapping with tetrad, mapping with molecular marker.

**References:** Larry Snyder and Wendy Champness, David Freifelder, Snyder, Russel, Griffith, Snustad and Simmons.

## E. Critical Review (20)

## **Practical**

**CREDIT-**

### **A. Recombinant DNA Technology, Genetics and Immunology 50**

Bacterial DNA isolation, DNA isolation from blood, Ligation, Restriction mapping, Restriction digestion, PCR, Southern Blotting, GFP cloning, SDS PAGE. Assay of bacteriophage, induction pattern of temperature sensitive lysogens, purification of bacteriophage, isolation of nucleic acids from bacteriophage. Transformation, Conjugation

Immuno Electrophoresis, Rocket Immuno Electrophoresis, ELISA, Western Blotting, Lymphocyte Count from Blood.

Review of research papers and presentation

### **B. Bioinformatics: 30**

Commenting on unknown protein structure using standard bioinformatics software, like FASTA, BLAST, PHYLIP

Problem solving in biology using Biostatistical methods (Analysis of variance etc)

**Semester: 4**

**CREDIT-**

**A] Industrial Microbiology and Food Technology: [DD] 25**

Biology of Industrial Microorganisms: (*Saccharomyces*, *Aspergillus*, *Penicillium*, Spore forming bacteria etc.). Idea of Fermentation, Cell growth, Metabolism, Regulation of Metabolism, Substrate Assimilation / Product Secretion. Different fermentative system. Batch & Continuous processes, Fermentor Design, Surface & Submerged liquid substrate Fermentation. Solid substrate Fermentations, Fermentation Raw Materials, Biofertilizers and biopesticide formulation, Down Stream Processing, Bio Mass Production. Concepts of Immobilized Enzymes.

Fermented food and its processing. Food Fermentation( Alcohol, Cheese making, Bread making, Soya based food, Meat Fermentation, Vinegar, Lactic Acid), Food Additives(Amino acids, Nucleosides, Vitamins, Fats & Oils), Genetically modified food, organic food and food processing. Industrial chemicals, Bio Polymers, Bio Insecticides, Health Care Products( Antibiotic, Steroid, Vaccines). Production of Industrial Solvents( Alcohol, Acetone, Butanol, etc.)Industrial Enzymes( Amylase, Proteases, Lipases), Nutraceuticals.

**References:** Casida, Prescott and Dunn, Waites, Crueger and Crueger.

**B] Medical microbiology: [AKM+DD] 35**

**History of infectious disease:** Koch's postulates, Molecular Postulates, Types of Pathogens-subcellular infectious entities, Prokaryotic and eukaryotic microorganisms. Normal microflora in healthy human body.

**Host- Parasite interactions:** Basic Terminology of Infectiology, Determinants of Bacterial Pathogenicity and Virulence, Adhesion, Invasion and spread and damage, action of toxins, Strategies against Nonspecific Immunity , Strategies against Specific Immunity, Regulation of Bacterial Virulence.

**Bacterial Diseases:** Mechanism of pathogenesis, prophylaxis, therapy, prevention and laboratory diagnosis of the diseases caused by *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Bacillus*, *Corynebacterium*, *Clostridium*, *Enterobacteriaceae*, *Shigella*, *Salmonella*, *E. coli*, *Vibrio*, *Mycobacterium*, *Helicobacter pylori* etc.

Other disease- Food Poisoning, Meningitis, Tuberculosis, Diphtheria, Leprosy, Typhoid, Enteritis [*Yersinia enterocolitica*], Gastritis, Cholera, Bacterial Pneumonia..

**Viral diseases:** Host-Cell Reactions ,Cell Destruction (Cytocidal Infection, Necrosis), Virus Replication without Cell Destruction (Noncytotoxic Infection), Latent Infection.

Mechanism of viral pathogenesis. Pathogenesis, symptoms, lab diagnosis, prophylaxis and treatment of Adenoviruses, Polioviruses, Herpesviruses, Pox viruses,, Hepatitis viruses, HIV viruses and Oncogenic viruses.

**Biology of obligate parasites :** Rickettsia, Chlamydia, Trypanosomes, Spirochetes etc. and diseases caused by these.

**Common Mycotic infections in humans :** Superficial, subcutaneous, cutaneous and systemic mycoses. General description of mycotic pathogens, diagnosis and prevention

## Hospital Infection

### Chemotherapeutic Agents

Definition, Concept of secondary metabolite, Role of antibiotics in producer organisms, Significance of antibiotic compounds in present world. Spectrum of action, efficacy, Assay of antibiotics- chemical versus microbiological assay system.

**Mechanisms of action:** Antibacterial compounds Cell wall inhibitors [penicillin, bacitracin], inhibitors of membrane function [polyenes, tunicamycin, ionophores] , inhibitors of ribosomal function [aminoglycoside, tetracycline, chloramphenicol, puromycin], inhibitors of nucleic acid metabolism [Actinomycin D, mitomycin C]

Antiviral compounds- Viral protein coat inhibitors, nucleotide analogs, Interferons

**Generations of Antibiotics:** Biochemical modifications for generation development of antibiotics taking example of antibiotic like penicillin etc.

**Antibiotic resistance:** The Problem of Resistance, Definitions, Incidence, Significance , Resistance Mechanisms, Evolution of Resistance to Anti-Infective Agents , Resistance Tests.

**Combination therapy :** Significance , side effects. Antagonism and synergism.

**Bacteriocins:** mode of action of some common bacteriocins; difference with antibiotics and uses.

**Antifungal agents:** examples and sites of action of some commonly used antifungal agents

**Reference:** Greenwood, Panikar

## C] Computational Biology and Biostatistics [AC] 35

**Number system and codes:** Binary, Octal, and Hexa-decimal number systems - Binary arithmetic, Binary code, Excess - 3 code Gray error detection and correction - Boolean algebra Computer Fundamentals: Block Diagram of a computer, CPU, Primary and Secondary Memory, Input and Output Devices. Introduction to operating Systems: WINDOWS, Linux operating systems; Computer Viruses. Computer Networking - LAN, WAN, MODEM; Security of the network, Fire-walls; Network Goals; Applications Network; Network structure; Network architecture; Use of INTERNET & w *Introduction to 'C' Language*

Character set, Variables and Identifiers, Built-in Data Types, Variable definition, Arithmetic operators and Expressions, Constants and Literals, Simple assignment statement, Basic input/output statement,

Simple 'C' programs

Introduction to Programming

The Basic Model of Computation, Algorithms, Flow-charts, Programming Languages, Compilation, Linking and Loading, Testing and Debugging, Documentation

Probability and statistics- conditional probability, population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, Probability distribution- Binomial, Poisson & Gaussian distributions, additive and multiplicative laws of probability, concept of correlation, regression, method of least squares, random number generation, testing and use; probability density and cumulative distribution function, systematic and random sampling; accidental and systematic errors, error function, propagation of error. Testing of hypothesis- test for mean, chi-square test ANOVA . Prey predator model (numerical modeling)- An introduction. Basic idea of applied multivariate techniques.

**References:** Das and Das, Misra.

**D] Virology [MMG] 30**

Classification and modes of propagation, bacterial, plant and animal viruses: morphology and ultrastructure, assay of viral particle, cell culture, viral enzymes, nucleic acids, bacteriophages: lambda, T4, T7, M13, lytic cycle, lysogeny, viral replication, nucleic acid and protein synthesis, viral diseases. Virus host interaction: virus infection, viral diseases and pathogenesis: Herpes, adeno, hepatitis, rhabdo, oncogenic viruses etc. DNA viruses: Herpes, hepatitis B, adenovirus, RNA viruses, polio, VSV, influenza, retroviruses: structure and lifecycle, transformation, baculoviruses, molecular biology of genetic shift and drift in influenza virus, cellular tropism of HIV, Plant viruses: TMV. Prions.

**References:** Flint, Dimmock, Ptashney, Maniatis, Powar Dagainawala, Subramanyam Sashtry. David Freifelder, Brock

**E] General concepts of patents related to biological research products  
Biosafety, Bioethics and IPR 25**

Basic principles and application and laws pertaining to patenting and its protection

## Practical

CREDIT-4

### A. Industrial Microbiology and medical microbiology [DD+KS] 30

Microbial production of amylase by *Bacillus subtilis*, Production of antimicrobial compounds from soil isolates. Fermentative production of ethanol by *S. cerevisiae*, Wild fermentation- Saurkraut production. Demonstration for production of amino acids by soil microbes, Isolation of an antibiotic resistant bacteria from soil & its biochemical characterization, Isolation of an antibiotic producer from soil. Determination of phosphatase activity of milk & Casein hydrolysis.

Examination of sputum for tuberculosis, Urine culture, Examination and isolation of dermatophytes.

### B. Computational biology and Biostatistics 30

Algorithms for Problem Solving

Exchanging values of two variables, summation of a set of numbers, Test whether a number is prime, Organize numbers in ascending order, Find square root of a number, factorial computation, Fibonacci sequence, Find largest number in an array, Print elements of upper triangular matrix, multiplication of two matrices, Evaluate a Polynomial.

Conditional Statements and Loops

Decision making within a program Conditions, Relational Operators, Logical Connectives statement, if-else statement loops: while loop, do while, for loop, Nested loops.

Arrays

One dimensional arrays: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; Two dimensional arrays, Addition/Multiplication of two matrices.

### C. General concepts of patients related to biological research products, seminars and project work 20

A project performance report based on the summer research training in a reputed laboratory will have to be submitted. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.