Syllabus for M.Sc. Microbiology Entrance Examination 2016-17

BACTERIOLOGY

Cell organization: Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. **Cell-wall**: Composition and detailed structure of gram positive and gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. **Cell Membrane**: Structure, function and chemical composition of bacterial and archaeal cell membranes. **Cytoplasm**: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. **Endospore:** Structure, formation, stages of sporulation. **Bacteriological techniques:** Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. **Growth and nutrition: ,** Nutritional requirements in bacteria and nutritional categories; **Culture media**: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. **Sterilization and Disinfection:** *Physical methods of microbial control*: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation, *Chemical methods of microbial control*: disinfectants, types and mode of action. **Reproduction in Bacteria:** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate. **Bacterial Systematics**, Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria. **Important archaeal and eubacterial groups: Archaebacteria**: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*)]. **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups: ***Gram Negative:*** Non proteobacteria *Aquifex, Thermotoga, Deinococcus, Thermus, Chlorobium, Chloroflexus, Chlamydiae, Spirochaetes.* Alpha proteobacteria *Rickettsia, Coxiella, Caulobacter, Rhizobium, Hyphomicrobium, Agrobacterium.* Beta proteobacteria: *Neisseria, Burkholderia, Thiobacillus.* Gamma proteobacteria: *Enterobacteriaceae* family, Purple sulphur bacteria, *Pseudomonas, Vibrio, Beggiatoa, Methylococcus, Haemophilus.* Delta proteobacteria: *Bdellovibrio, Myxococcus*: Epsilon proteobacteria, *Helicobacter, Campylobacter.* ***Gram Positive:*** Low G+ C (Firmicutes), Mycoplasmas, *Clostridium, Heliobacterium, Lactobacillus, Lactococcus, Staphylococcus, Streptococcus, Leuconostoc, Bacillus.* High G+C (Actinobacteria) *Arthrobacter, Bifidobacterium, Corynebacterium, Frankia, Mycobacterium, Nocardia, Streptomyces, Thermomonospora, Propionibacterium.* ***Cyanobacteria :*** *An Introduction*

PHYCOLOGY & MYCOLOGY

Phycology. **Classification of Algae, Study of the following classes with reference to genera listed below (occurrence, thallus organization and life cycles):** Chlorophyceae*: Volvox, Coleochaete,* Charophyceae: *Char,* Diatoms: General features with reference to pinnate and centric diatoms, Xanthophyceae: *Vaucheria,* Phaeophyceae: *Ectocarpus,* Rhodophyceae: *Polysiphonia*, Cyanobacteria: *Nostoc ,* **Applications of algae** in Agriculture, Industry, Environment and Food**.** ***Mycology:*** **Classification of fungi Study of the following classes with reference to the genera listed below (occurrence, somatic structure and life cycles):** Cellular slime molds – *Dictyostelium,* True slime molds (Myxomycetes) - *Physarum* **,** Oomycetes - *Saprolegnia, Phytophthora,* Chytridiomycetes – *Neocallimastix,* Zygomycetes – *Mucor,* Ascomycetes - *Saccharomyces, Penicillium, Neurospor,* Basidiomycetes – *Agaricus,* Deuteromycetes - *Candida, Alternari,* **Lichens, Economic importance of fungi with examples** in Agriculture, Environment, Industry, Medicine, Food, Biodeterioration (of wood, paper, textile, leather), Mycotoxins

VIROLOGY

Introduction: Discovery of viruses, nature and definition of viruses, general properties of viruses. Concept of viroids, virusoids, satellite viruses and prions. Theories of viral origin**. Structure of viruses** Capsid symmetry, enveloped and non-enveloped viruses**. Isolation, purification and cultivation of viruses, Viral Taxonomy:** Classification and nomenclature of different groups of viruses infecting microbes, plants and animals**. Salient features of viral genomes:** Unusual bases (TMV, T4 phage), overlapping genes (ΦX174, Hepatitis B virus), alternate splicing (Picornavirus), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), ambisense genomes (arenavirus), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (influenza virus) and non segmented genomes (picornavirus), capping and tailing (TMV). **Bacteriophages:** Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda and P1 phage), concept of early and late proteins, regulation of transcription in lambda phage and applications of bacteriophages. Viral multiplication and replication strategies. Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification. Assembly, maturation and release of virions. Concept of defective particles. Transmission of viruses **,**Persistent and non-persistent mode. Oncogenic viruses. Types of oncogenic DNA and RNA viruses. Concepts of oncogenes, protoncogenes and tumor suppressor genes. Prevention and control of viral diseases. Antiviral compounds, interferons and viral vaccines. **Applications of Virology.** Use of viral vectors in cloning and expression, Gene therapy and Phage display

MICROBIAL PHYSIOLOGY AND METABOLISM

Nutritional classification of microorganisms based on carbon, energy and electron sources**. Metabolite Transport.** Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron. **Microbial Growth:** Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. **Measurement of microbial growth:** Measurement of cell numbers, cell mass and metabolic activity**. Effect of the environment on microbial growth:** Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure.
Chemolithotrophic metabolism: Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogen-oxidizing bacteria and methanogens. **Phototrophic metabolism:** Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. **Carbon dioxide fixation:** Calvin cycle and reductive TCA cycle. **Enzymes and their regulation:** Importance, structure and classification of enzymes. Apoenzyme and cofactors. Prosthetic group, coenzyme and metal cofactors. Active site and its salient features. Mechanism of enzyme action. Activation energy, Lock and key hypothesis, induced fit. Enzyme kinetics and inhibition. Substrate saturation curve, Michaelis-Menten kinetics, Lineweaver-Burke plot. Effect of pH and temperature on enzyme activity. Enzyme unit, specific activity, turnover number. Irreversible and reversible inhibition: competitive and non-competitive inhibition. Enzyme regulation. Synthesis: introduction of enzyme induction and repression. Activity: allostery, covalent modification and feedback inhibition. Multienzyme: pyruvate. dehydrogenase complex, isozymes: lactate dehydrogenase. **Microbial Energetics:** Concept of aerobic respiration, anaerobic respiration and fermentation. Central metabolic pathways: EMP pathway, ED pathway, PP pathway, and TCA cycle. Anaplerotic reactions, gluconeogenesis, glyoxylate cycle. Mitochondrial and bacterial electron transport. Oxidation-reduction potential and energetic of electron transport. Components of respiratory chain, and their inhibitors. Anaerobic respiration, denitrification, nitrate/nitrite respiration. Oxidative phosphorylation: ATP synthesis and ATP synthase. Uncouplers, inhibitors and ionophores. Chemical coupling, conformational coupling and chemiosmotic hypotheses. Fermentations: alcohol fermentation, Pasteur effect, lactate and

butyrate fermentation, Fermentation balances, branched *versus* linear fermentation pathways. **Nitrogen Fixation**: Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation. Nitrogen fixers and mechanism of nitrogen fixation, properties of nitrogenase, and ammonia assimilation. Genetics of nitrogen fixation and regulation of nitrogenase activity and synthesis. Alternate nitrogenase

CELL BIOLOGY

An Overview of Cells Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viriods, Mycoplasma and *Escherichia coli*. **Tools and techniques of Cell Biology**: Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy; Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy; **Analytical**-Flow cytometry-flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis. **Separation**-Sub-cellular fractionation- differential and density gradient centrifugation; Chromatography- paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC). **Composition of Cells:** Molecules of cell, cell membranes and cell Proteins. **The Nucleus:** Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing. **Protein Sorting and Transport:** The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes. **Mitochondria, Chloroplasts and Peroxisomes:** Structural organization, Function, Marker enzymes,Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes'assembly. **Cytoskelton and Cell Movement:** Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules. **The Plasma Membrane** : Structure; Transport of small molecules, Endocytosis. **Cell Wall, the Extracellular Matrix and Cell Interaction:** Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions. **Cell Signaling**: Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks. **Cell Cycle:** Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization. **Cell Death and Cell Renewal**: Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning. **Cancer:** Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment-molecular approach.

MOLECULAR BIOLOGY

Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics. **The Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure**.** Organelle DNA -- mitochondria and chloroplast DNA. **Genome Structure, Chromatin and the Nucleosome:**Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome. Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes. **The Replication of DNA (Prokaryotes and Eukaryotes):** Chemistry of DNA synthesis, general principles - bidirectional replication, Semi- conservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins. **The Mutability and Repair of DNA:** Replication Errors, DNA Damage and their repair. **Mechanism of Transcription:** RNA Polymerase and the transcription unit**.** Transcription in Prokaryotes**.** Transcription in Eukaryotes**. RNA Modifications:** Split genes,

concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.**Translation (Prokaryotes and Eukaryotes):** Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation**.** Translation-dependent regulation of mRNA and Protein Stability. **Transcription Regulation in Prokaryotes:** Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons**. Transcription Regulation in Eukaryotes:** Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing. **Regulatory RNAs:** Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X-inactivation

MICROBIAL ECOLOGY

History, significance and developments in the field of microbial ecology: Contributions of Beijerinck, Winogradsky, Kluyver, Van Niel, Martin Alexander, Selman A. Waksman**. Microorganisms & their natural habitats**: *Terrestrial Environment*: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora. *Aquatic Environment*: Stratification & Microflora of Freshwater & Marine habitats. *Atmosphere*: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes. *Animal Environment*: Microbes in/on human body (Microbiomics) & animal (ruminants) body. *Extreme Habitats*: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. **Succession of microbial communities in the decomposition of plant organic matter. Biological Interactions:** *Microbe–Microbe Interactions.* Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents. *Microbe–Plant Interactions:* Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/non-symbiotic - biofertilizers). *Microbe–Animal Interactions*. Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont. **Biogeochemical cycles an introduction.** *Carbon cycle:* Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin). *Nitrogen cycle*: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution. *Phosphorous cycle*: Phosphate immobilization and phosphate solubilization. *Sulphur Cycle:* Microbes involved in sulphur cycle. **Solid Waste Management:** Sources and types of solid waste, methods of disposal of solid waste (incineration, composting, sanitary landfill)**. Liquid Waste Management:** Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, imhoff tank, anaerobic digestor) and tertiary sewage treatment**. Bioleaching. Biodeterioration.** Microbial deterioration of metals (corrosion), textile and paper

PLANT PATHOLOGY

Introduction and History of plant pathology: Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton De Bary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists. **Stages in development of a disease:** Infection, invasion, colonization, dissemination of pathogens and perennation. **Plant disease epidemiology:** Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context. **Host Pathogen Interaction.** *Microbial Pathogenicity.* Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development.
Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). *Genetics of Plant Disease:* Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis,

types of plant resistance: true resistance– horizontal & vertical, apparent resistance.*Defense Mechanisms in Plant:* Concepts of constitutive defense mechanisms in plants**,** inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts]. **Control of Plant Diseases:** Principles & practices involved in the management of plant diseases by different methods, *viz* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes. **Specific Plant disease:** Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control**.** ***Important diseases caused by fungi:*** White rust of crucifers - *Albugo candida***,** Downy mildew of onion - *Peronospora destructor***,** Late blight of potato - *Phytophthora infestans***,** Powdery mildew of wheat - *Erysiphe graminis,* Ergot of rye - *Claviceps purpurea***,** Black stem rust of wheat - *Puccinia graminis tritici***,** Loose smut of wheat - *Ustilago nuda***,** Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici***,** Red rot of sugarcane - *Colletotrichum falcatum***,** Early blight of potato - *Alternaria solani***.** ***Important diseases caused by phytopathogenic bacteria:*** Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus. ***Important diseases caused by phytoplasmas:*** Aster yellow, citrus stubborn**.** ***Important diseases caused by viruses:*** Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro. ***Important diseases caused by viroids****:* Potato spindle tuber, coconut cadang cadang

IMMUNOLOGY

Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa. **Immune Cells and Organs:** Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT**. Antigens:** Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants**. Antibodies**: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies**. Major Histocompatibility Complex**: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)**. Complement System**: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation**. Generation of Immune Response :** Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance**. Immunological Disorders and Tumor Immunity:** Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens**. Immunological Techniques**: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR

INDUSTRIAL MICROBIOLOGY

Introduction to industrial microbiology: Brief history and developments in industrial microbiology. **Fermentation processes:** Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fed-batch and continuous fermentations . **Bioreactors/fermenters:** Components of a typical

bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. **Measurement and control of fermentation parameters:** pH, temperature, dissolved oxygen, foaming and aeration. **Isolation of industrially important microbial strains:** Primary and secondary screening, strain development, preservation and maintenance of industrial strains. **Media and ingredients for industrial fermentations:** Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract. **Down-stream Processing:** Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying. **Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses).** Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations. **Enzyme immobilization:** Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase**)**

GENETICS AND GENOMICS

Introduction to Genetic Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. **Mitosis and Meiosis:** Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).**Mendelian Genetics and its Extension**: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance. **Linkage, Crossing Over and Chromosomal Mapping:** Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping. **Mutation:** Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms. **Sex Determination** Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation. **Extrachromosomal Inheritance:** Chloroplast mutation/Variegation in Four o' clock plant and *Chlymodomonas,* Mitochondrial mutations in *Neurospora* and yeast, Maternal effects, Infective heredity- Kappa particles in *Paramecium.* **Quantitative Genetics:** Quantitative and multifactor inheritance, Transgressive variations, Heterosis. **Genetic Analysis and Mapping in Bacteria and Bacteriophages :** Conjugation; Transformation; Transduction, Recombination. **Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses:** Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in *Drosophila*; Uses of transposons; Eukaryotic Viruses. **Developmental Genetics and Model System:** Study of model systems in developmental genetics- *Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana,* and *Xenopus laevis*. **Genomics, Bioinformatics and Proteomics:** Genomes of bacteria, *Drosophila* and Humans*;* Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification. Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction. **Genomic Analysis- Dissection of Gene Function:** Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology. **Population Genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.**Evolutionary Genetics:** Genetic variation and Speciation.

MEDICAL MICROBIOLOGY

Normal microflora of the human body: Skin, throat, gastrointestinal tract, urogenital tract. **Host-pathogen interaction:** Definitions of invasion, pathogen, parasite, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection**. Sample collection, transport and diagnosis:** Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes). **Bacterial diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control)** *Bacillus anthracis, Corynebacterium diphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and paratyphi, Shigella dysenteriae, Helicobacter pylori, Vibrio cholerae, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Treponema pallidum).* **Viral diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control)** Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza with brief description of bird and swine flu, Dengue, AIDS, Viral cancers. An overview of emerging viral diseases: Japanese Encephalitis, Ebola, Marburg, SARS, Hanta, Nipah, Chandipura, Chikungunya. **Introduction to protozoan diseases:** Malaria, Kala-azar, and Toxoplasmosis. **Introduction to fungal diseases:** Different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses**. Antimicrobial agents and drug resistance:** Mechanism of action of important chemotherapeutic agents. Principles of drug resistance in bacteria

FOOD AND DAIRY MICROBIOLOGY

Foods as a substrate for microorganisms: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general**. Microbial spoilage of various foods:** Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods**. Principles and methods of food preservation:** Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins**. Fermented foods**: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh and probiotics. **Food borne diseases (causative agents, foods involved, symptoms and preventive measures).** Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni***. Food sanitation and control:** HACCP, Indices of food sanitary quality and sanitizers. **Water Potability:** Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

RECOMBINANT DNA TECHNOLOGY AND BIOTECHNOLOGY

Introduction to basic biotechnology: Milestones in genetic engineering and biotechnology**. Tools of recombinant DNA technology:** *Hosts, E. coli* strains; Yeast (*Saccharomyces cerevisiae, Pichia pastoris*); Fungi (*Penicillium*, *Aspergillus*); Mammalian cell lines - names and genotypes**.** *Enzymes:* Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease**.** *Vectors:* Cloning Vectors- Definition and Properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs. *Mammalian Expression Vectors:* SV40, Vaccinia, Retroviral promoter based vectors**.**

Basic DNA Cloning: Simple cloning of DNA fragments, Vectors: Definition and properties. *E. coli* expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors - pET yeast vectors, YIp, YEp and YCp vectors. Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation**.** Methods of gene delivery in plants and animals**.** Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium*-mediated delivery**. Methods of DNA, RNA and Protein analysis and DNA typing:** Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display**. Amplification of nucleic acids:** Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction**: Construction of Genomic and cDNA libraries:** Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR**. DNA sequencing and synthesis**: Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project**. Product of DNA technology**: Human protein replacements-insulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal