SYLLABUS FOR LAB ASSISTANT EXAM (MICROBIOLOGY) 2014

1) Basics in Chemistry (Inorganic)
2) History of Microbiology and Microbial systematic
3) Cell Biology
4) Microbial nutrition
5) Techniques in Microbiology and Biochemistry
1) Basics in Chemistry-II (Physical)
2) Microbial growth and control
3) Macromolecules: structure & function
4) Microbial ecology
5) Biostatistics and Introduction to Computer

1) The chemical elements: Varieties of matter; atoms, molecules and ions; atomic structure and isotopes; the periodic law and chemical bonding; atomic weight, the mole, molecular weight and molecular formula; ionic equations, stoichiometry in solutions, molarity, molality, titration; gaseous laws, Boyle's law, Charle's law, Dalton's law of partial pressure, ideal and non-ideal gas, Vander Waals equation.

The wave equation; quantum numbers, orbitals annd their shape; energy diagrams, electroic configuration of atoms, Hund's rule, atomic sites, Magnetic properties.

2) Energy relations: Energy, heat, heat capacity; heat of reaction, thermodynamic quantities; enthalpy changes, standard states, bond energies; free energy and entropy; laws of thermodynamics spontaneous and non-spontaneous changes, reversible and irreversible processes.

Oxidation and reduction: Oxidation number; oxidation – reduction reactions and balancing of such reactions; disproportionation, equivalent weight, normality; redox titrations.

History of Microbiology:

Early observations of microorganisms
Establishing microbes as living organisms
Theory of spontaneous generation
Birth of Microbiology as science
Germ theory of disease
Koch's postulates
Pasteur's contributions
Various branches of Microbiology

Microbial Systematics:

Concept of microbial species
What is microbial Taxonomy?
General methods of classifying bacteria
Bacterial nomenclature
Modern trends in bacterial Taxonomy
Bergey's system of bacterial classification
Classification of algae and fungi
Major groups of microorganisms

- Bacteria
- Fungi
- Algae
- Protozoa

Cell: basic organisational unit of living system. Morphology and arrangement of bacteria

Ultrastructure of cell and cell appendages : cell wall and cell envelopes, chemical composition of Gm+, Gm-, mycobacterial and archaebacterial cell wall.

Cell membrane: structure and chemical composition of bacterial including archaebacterial cell membrane.

Flagella: structure and arrangement of bacterial flagella including periplasmic flagella of spirochaetes, bacterial motility

Fimbria and pili: classes and structure of pili

Capsule and slime layer : chemical composition
Spore : fine structure and chemical composition of spores of bacteria
Cytoplasmic inclusions : PHB, volutin, lipids, starch
Nuclear material of bacteria and archaebacteria
Extrachromosomal elements : classes of plasmids
Ribosome : structure and chemical composition of bacterial ribosomes
Mesosomes
Specialised structure of cyanobacteria : heterocyst

Microbial nutrition and energetics.

Introduction to terms : Metabolism, catabolism, anabolism.
Nutritional requirements of microorganisms : C, N, macronutrients, micronutrients, growth factors.
Principles of medium ingradients and various types of routine and specialized media; define and complex media, differential and enriched media.
Energy classes of microorganisms : chemoorganotrophs, chemolithotrophs, phototrophs, autotrophs, heterotrophs.
Energetics : free energy, exergonic and endergonic reactions, oxzidation - reduction, electron carriers.

Isolation and culture of microorganisms

Culture media, defined and complex
Enrichment culture technique
Isolation of pure culture
Aseptic technique and streak plate
Spread plate and pour plate techniques
Enumeration of bacterial, direct microscopic count, viable count, MPN technique, turbidometry.
Cultivation of anaerobe, use of gaspale for preparing anaerobic jar.
Cultural characteristics
Identification and characterization of bacteria using biochemical tests.
Isolation and cultivation of fungi
Maintenance and preservation of microorganisms : culture collection centres
Electrochemistry: Electrolysis, Faraday's laws; half cell potentials; Nerust equation; concentration cells; potentiometric titrations; fuel cells.
Kinetics and equilibrium : Reaction kinetics and rate laws; half life of first and second order reactions; molecularity; effect of temperature and catalyst; Le Chatelier's principle; equilibrium constants and relation with free energy.
Acids and bases: Theories of acids and bases; relative strengths; dissociation constants, pK_a, pK_b and pH; common ion effect; buffer solution, indicators, measurement of pH; solubility and solubility product; applications of solubility product.
Bacterial growth: Reproduction in bacteria, binary fission, cell elongation, DNA replication, septum formation.
Bacterial growth phase : lag, exponential, stationary and death phase.
Measurement of growth : Turbidometry, protein measurement
Factors affecting microbial growth : pH, temperature, nutrient, etc.
Growth of bacterial cultures : batch, continuous and synchronous, turbidostat, chemsotat, methods of obtaining synchronous culture.
Diaukie growth
Fungal growth measurement : dry weight, protein, DNA measurement.
Control of microbial growth : physical control : high temperature, low temperature, radiation, filtration, dessication.
Chemical control : Disinfectant, salt, sugar, organic acids, nitrate, nitrite, SO_2, ethylene oxide (food preservatives)
Antiseptics
Antibiotics and chemotherapeutic agents.
Water : Physical and chemical properties of water.

Carbohydrates : Structure and function of mono- di, oligo and polysaccharide.
Polysaccharides as storage and as structural component in cell.
Proteins : amino acids, structure, characteristics, classification and function.
Primary, secondary, tertiary and quarternary structure of proteins.
Lipids : chemistry, structure, classification and function.
Nucleic acids : structure, types and function.
Microbial intractions with each other : synergism, parasitism, amenalism, commercialism, etc.
Interaction of microorganisms with plants and animals. Rumen microbial ecosystem
Microbial diversity in different habitats; aquatic habitat; marine, fresh water, deep sea, terrestrial habitat, hydrothermal vast, hot springs
Effect of environmental factors on ecological distribution and adaptations to environmental conditions.
Biogeochemical cycles : human characterization and microbial degradation
Carbon cycle, nitrogen, phosphorous, sulfur and iron cycle
Plant microbes interactions : agrobacterium - plant interaction, root nodule bacteria and symbiosis with legumes, crown gall and hair root
Organic chemistry : Hydrocarbons; functional groups and characteristic reactions of functional groups; alcohols, aldehydes, ketones, carboxylic acids, esters – their preparation and properties, carbohydrates.
Water : physical and chemical properties of water
Carbohydrates : structure and function of mono-, di-, oligo and polysaccharide.
Proteins, amino acids, structure, characteristics, classification and function.
Lipids : Chemistry, structure and function.
Nucleic acids : structure and function
Vitamins & cofactors : water soluble and fat soluble, structure function & function in physiology.
Pigments and porphyrin compounds.
Metabolism : Anabolism and catabolism, amphibolic and anaplerotic pathways. Primary and secondary metabolism : methods of studying metabolism.
Metabolism of carbohydrates : Glycogenolysis, glycolysis, gluconeogenesis
TCA cycle : general reactions
Lipid metabolism : α, β and mega oxidation.
Nucleic acid metabolism : Enzymes for the synthesis and degradation of nucleic acids.
Amino acid metabolism.
Enzymes : Structure and function, nature of active site, Michaelis-Menten equation, inhibitors, multiple forms of enzymes, isozymes, allosteric enzymes, feedback inhibition, enzyme assays, localisation of enzymes, use of enzymes in diagnosis.
Gene concept : units of a gene cistron, recognition, mutant, gene diversity, split genes, overlapping genes.
Mutation and mutagenesis : spontaneous mutation, chemical and physical mutagenesis, detection and isolation of mutants.
Genetic code : codon assignment of genetic code, the Wobble hypothesis, origin and evolution of genetic code.
Gene expression : central dogma, steps in transcription and translation in prokaryotes and eukaryotes.
Regulation of gene expression : Operon concept, lac operon as a model of regulation of gene expression.
Chromatography : Principle and types : paper, thin layer, column, ion exchange, affinity.
Electrophoresis : Principle and types : paper, thin-layer, Lig-Lig, GLC, gel permeation, ion exchange, affinity, HPLC
Colorimetry : Bears lamsert law
Spectrophotometer :
Centrifugation :
Concept of pH and buffers : Hendersen-Harselbach equation

Acids and bases - Bronsted-Lowry theory, strength of acids and bases, buffers, measurement of pH, use of indicators, interaction of acid and base.

Diffusion and osmosis : significance in biology

Viscosity : factors affecting, measurement and applications

Surface tension : measurement

Adsorption : Importance of absorptive interactions

Spectroscopy : Basic principles, laws of absorption, instrumentation chromatography of UV, vis, IR spectrophotometer

Centrifugation : RCF, instrumentation, preparative, differential and density gradient centrifugation, ultracentrifuge.

Electrophoresis : Migration of ions in electric field, factors affecting electrophoretic mobility, types : paper, cellulose, acetate, gel specialised technique. Disc; high voltage, isoelectric focussing.

Radioisotopes : Radioactive decay, isotopes, measurement of radioactivity, photography.

Monometry : Use of manometers : Warburg, Gilson Applications.

Basic concept of fermentation, types of fermentation processes, aerobic, anaerobic, surface, submerged, batch and continuous, dual.

Fermentation equipments and their uses : fermentor design, types of fermentors, equipments used in fermentation and downstream processing, general layout of fermentation plant.

Downstream processing : processes used in extraction, recovery and purification of products.

Screening, preservation and strain development of industrial microorganisms, stock cultures, culture collection centres.

Common raw materials used in fermentation, factors affecting fermentation, antifoams, phage attacks.

Scale-up of fermentations

Typical fermentation processes : citric acid, penicillin, acetone-butanol, ethanol, amylase.

Vaccines and sera : production, synthetic and recombinant vaccines.

Patents

Food microbiology : microbial flora of fresh foods, microbial spoilage of foods including canned food, food poisoning and infections, aseptic handling and processing of food, methods of preservation of food; sterilisation, low and high temperature, dehydration and canning, food produced by microorganisms.

Fermented vegetables : sairkrant, soy sauce.

Alcoholic beverages : wine, beer, liquors.

Bacteriological examination of food

Single cell protein : Advantages of mos as SCP, extraction of protein, SCP production using yeast, hydrocarbons, commercial processes, spirulina production.

Dairy microbiology : Types of microorganisms in milk, role of mos in spoilage of milk, pasteurisation methods of milk, determination of efficiency of pasteurization.

Cheese making : types of cheeses, process of cheese production, ripening of cheese, fermented milk products.

Air microbiology : kinds of microorganisms in air, technique of microbiological sampling of air, air-borne diseases and prevention.

Aquatic microbiology : The aquatic environment, distribution of aquatic microorganisms and their role.

Drinking water : pollution, purification, microorganisms as indicators of water quality, bacteriological examination of potability of water, nuisance bacteria in water systems, coliforms and water borne disease.

Wastewater microbiology : Sewage composition, characteristics, characterization of sewage : COD, BOD5, TOC, municipal processes of wastewater treatment, aerobic : trickling filter, activated sludge process, oxidation pond, anaerobic digestor, septic tank, methane production, solid waste disposal.

Bioleaching : Recovery of metals and oil.

Biofertilizers : Production of biofertilizers, criteria for strain selection. Types of biofertilizers : bacterial, algal, phosphate solubilizing microorganisms, mycorrhizal (ectomycorrhizal and VAM fungi) mass cultivation of biofertilizers and their applications.

Plant growth promoting rhizobacteria : types and mechanism of plant growth promotion.
Microbial herbicides : Microbial insecticides, pseudomonas and bacillus as bacterial insecticides.
Transgenic plants : Transfer systems, herbicide, pathogen, insect pest, frost resistant.
Plant pathology : plant diseases caused by bacteria and fungi. Life cycles of pathogens.
Epidemiology and public health
Disease transmission, diagnosis and prevention
Prevention : preventing exposure to pathogens
Immunization
Hard immunity
Vaccines and sera, toxoids, antitoxins.
Science of epidemiology
Descriptive and analytical epidemiology
Experimental studies
Disease outbreaks
Reservoirs of pathogens
Epidemics
Disease transmission : Portals of entry airborne, food and water born transmission
Sexually transmitted diseases
Zoonoses - vector transmission
Diseases transmitted through skin contact
Nasocomial and blood borne infections
Protozoan diseases : Plasmodial diseases (life cycle, chemotherapy, malarial vaccines, Trichomona, Vaginalis, Giardia, Tryptosoma, Entamoeba, histolytica, plasmodium).
Fungal diseases : mycoses; mycotoxicoses, clinical types, culture characteristics, pathogenesis and therapy.
Bacterial diseases
Airborne disease : tuberculoses; immunity, diagnosis, diphtheria, pertusis.
Food borne and water borne diseases : cholera, botulism, shigellosis, typhoid fever.
Soil borne diseases : tetanus sexually transmitted contact diseases (gonorrhea, syphilis)
Diagnostic principles in clinical microbiology and biochemistry, antibiotic susceptibility, blood, urine testing for sugar, cholesterol.
History of immune system and immunity
Types of immunity : Innate and acquired
Cells and organs of the immunosystem and their function
Antigens
Immunoglobulins structure and function
Generation of antibody diversity
Major histocompatibility complex
The complement system
Hypersensitive reactions
Cell mediated immunity
Immune response to infectious diseases
Immunology / Clinical Biochem.
Techniques in biochemical investigation of diseases
Investigation in diabetes, UTI, blood gastric function, liver, biliary functions
Clinical enzymology
Hormones, vitamins determination
Immunodiagnostics
Diagnosis of infectious disease
Differential blood counts
Skin testing
Antibody titre
Isolation and identification of pathogens
Metabolic identification : Enterotubes; serologic identification; gene probe identification.

Antigen-antibody interactions - precipitation reactions; agglutination reactions
Radioimmunoassay
Enzyme - linked immunosorbent assay
Western blotting
Immunoflorescence
Immunoelectron microscopy
Vaccines : Techniques for measuring the potency of vaccines and their response to various infectious diseases.
Techniques for cell mediated immunity measurement.
Monoclonal antibodies
Historical account : general properties of viruses, occurrence and morphology; shape and size of plant / animal viruses, viroids and prions.
Classification of viruses
Isolation and cultivation of viruses, CPE effects, pathogenesis of viral infection
Animal viruses : pox viruses, herpes, adene, hepatitis, picorna, arbo, rhabdo, retro viruses, AIDS and _____
Bacteriophages types, physiology of phage multiplication.
RNA and DNA containing bacteriopahges
Plant virus - TML
Classical genetics : Mandelian genetics, patterns of inheritance, Mendalian/ non-Mendalian; chromosome structure & number; sex chromosome; methods of chromosome analysis; mitosis; meiosis.
Microbial genetics : Types of gene transfer in bacteria; transformation, conjugation and transduction; transposable elements; classes and nomenclature, insertional elements, mechanism of transposition.
Plasmids : types, characteristics and classification.
Aerobic respiration : Oxidative phosphorylation, ATP generation, generation of reducing power, chemiosmotic theory.
Anaerobic respiration : nitrate reduction, denitrification, sulfate reduction.
Methanogenesis and acetogenesis : CO_2 as electron acceptor
Fermentation : Energetics and redox consideration oxidation - reduction balance, alcoholic, homo-heterolactic, propionic, mixed acid, butyric, butanediol, caproate, butanol fermentations.
Chemoautotrophs (chemolithotrophs) : H_2, sulfur, iron oxidation.
Photosynthesis :
Membrane transport : Types of cellular transport
Passive diffusion, osmosis, facilitated diffusion
Active transport : proton-motive force - Na-K pump; group translocation; binding protein transport.
Nitrogen fixation : symbiotic and non-symbiotic nitrogen fixation.
Bioluminescence : bacteria showing bioluminescence, biochemistry of bioluminescent reaction, lux genes and applications of bioluminescence.
Bacterial photosynthesis : photosynthetic structures, types of bacterial photosynthesis, photosynthesis pigments and electron transport system.
Genetic engineering : plasmids and other cloning vehicles, enzymes in genetic engineering, techniques : sequencing, analysis by souther, northern and western blot, cDNA technology, gene amplification by PCR.
Cell culture of plants and animals
Biotechnology in health and medicine : monoclonal antibodies, ELISA, subunit vaccines, genetically engineered vaccines, diagnosis of infectious diseases, development of novel drugs, pharmaceutical biotechnology production of human insulin etc., cloning in animal breeding, gene therapy, transgenic animals.
Biotechnology in food and agriculture : microbial insecticides, transgenic biotechnological improvement of nutritive value, pathogen resistance, herbicide resistance etc.
Biotechnology in environment and energy : bioremediation, biosensors, biopolymers, bioenergy, waste management.

Ultrastructure of eukaryotic cell: animal and plant cell
Cytoplasmic inclusions: starch, glycogen
Nuclear and chromosome in eukaryotes
Cell organelles in eukaryotic cell : Mitochondria, chloroplast, golgi bodies, endoplasmic reticulum, microbodies, lysosmes (structure and chemical composition)
Ribosome : structure and chemical composition
Fungal cell wall andcell membrane : structure and chemical composition
Protozoa : structure and organisation of citra and flagella