



GOA UNIVERSITY
Taleigao Plateau

SYLLABUS FOR GOA UNIVERSITY ADMISSIONS RANKING TEST (GU-ART) IN MICROBIOLOGY AND MARINE MICROBIOLOGY

I. Introduction to Microbiology and Biochemistry

Introduction and historical aspects of Microbiology

Types of Microorganisms; Distribution of microorganisms in nature, Brief description of classification schemes proposed by Linnaeus, Haeckel, Whittaker, Woese. Development in microscopy; Discovery of the microbial world; theory of spontaneous generation vs. biogenesis; Germ theory of diseases, aseptic surgery.

Microbial associations

Types of associations: mutualism, commensalism, synergism, syntrophism, competition, antagonism, parasitism, predation; Ectosymbiosis and Endosymbiosis of plants, animal and other microorganisms. Examples of each type of interaction - mycorrhizal, root nodules, ruminant symbiosis, termites, bioluminescent bacteria.

Microbial cytology

Diversity in microbial cytology. Structure of eukaryotes and prokaryotes (Archaeobacteria and Eubacteria) and differences. Organization and ultrastructure of prokaryotic cell (Bacterial cell). Cell wall: structure and composition in Gram positive and Gram negative bacteria, sphaeroplast, protoplast, L-forms; Flagella and pili; Cell membrane: architecture, structure & function; Slime and capsule: composition, function; Cytoplasmic organelles; Nuclear material: nature and function; Endospore: structure, sporulation and germination.

General characters and economic importance of Groups of Microorganisms:

Rickettsias (*Coxiella*, *Rickettsia*), Actinomycetes (*Nocardia*, *Streptomyces*), Cyanobacteria (*Oscillatoria*), **Algae, Yeasts, Molds, Protozoa, Viruses** (Viral replication (lytic and lysogenic), Cultivation).

Introduction to Biochemistry

Carbohydrates: Trioses, tetroses, pentoses, hexoses, optical isomerism, pyranose and furanose forms, alpha/beta forms, reducing sugars, disaccharides, glycosidic bonds, lactose, maltose, sucrose, polysaccharides - storage: glycogen, starch; structural: cellulose. Principles of carbohydrate determination: Total carbohydrates by phenol sulphuric acid method, reducing sugars by DNSA method.

Amino acids: L & D forms, zwitterion, amphoteric nature, R groups, naturally occurring amino acids. Detection of amino acids by Ninhydrin method.

Proteins: peptide bond, primary, secondary, tertiary, quaternary structure. Protein determination: UV absorption, Colorimetrically by Biuret & Folin Lowry method.

Lipids: Principles of lipid determination, Fatty acids & triglycerides: unsaturated fatty acids.

Nucleic acids: purines & pyrimidines, nucleosides & nucleotides; principle of determination of DNA by diphenylamine and RNA by Orcinol methods.

II Techniques in Microbiology

Nutrition

Nutritional Types: phototrophs, chemotrophs & their subgroups. Autotrophs and heterotrophs. Facultative types, fastidious groups (definition) e.g. *Mycobacterium*, *Streptococcus*. Basic nutritional requirements; Sources of C, N, S, P, O, H, micro nutrients, growth factors, organic/ inorganic electron donors

Physico-chemical conditions

pH: acidophiles, alkalophiles, neutrophiles, Temperature: psychrophiles, thermophiles, mesophiles; Oxygen tension: aerobic, microaerophilic, anaerobic; use of pre-reduced media (Thioglycolate, Robertson's cooked meat), Anaerobic jar; Other conditions: osmotic pressure (osmophiles, halophiles), hydrostatic pressure (barophiles).

Cultivation and growth

Types of culture media: synthetic, complex, enriched, enrichment, selective, differential, dehydrated solid and liquid. Buffers & their use in culture media. Definition of cell growth/population growth; generation time - definition & formulae, Bacterial growth curve, characteristics of growth phases; diauxic growth. Synchronous growth. Batch/Continuous cultures: principles, steady state, chemostat/Turbidostat.

Preparation of Laboratory Media: Peptone water, nutrient broth and agar, preparation of slants and butts, Saboraud's broth and agar, MacConkey's broth and agar. Growth curve of *E. coli*. Effect of protein synthesis inhibitor (antibiotic) on bacterial growth.

Enumeration

Physical methods: Direct counting - microscopic counts (Breed's count, Haemocytometer count); Indirect counting - turbidometry (use of colorimeter), Dry-weight, wet-weight, PCV (Packed Cell Volume).

Biological methods: Direct counting - SPC (serial dilution, viable counts, colony counts), membrane filter method; Indirect counting - MPN. IMViC tests.

Principles and methods of light and advanced microscopy

Principles of optics, magnification, resolution, angular aperture, focal length, mechanical tube length. Types of optical microscopes - simple, compound, binocular. Lens systems: Objectives: low power, high power, oil immersion, function & importance, Eyepiece: Huygenian, Ramsden, Hyperplane, compensating ocular. Condensers: Abbe, Aplanatic, achromatic, differences & applications. Micrometry & its use. Principles underlying the construction, working and ray diagram of: Dark field microscope, Fluorescence microscope, Phase contrast microscope, Electron microscope - SEM & TEM.

Effect of Physical and chemical agents on bacteria

Physical agents: Low and high temperature - cardinal points of temperature; Osmotic pressure - plasmolysis, plasmoptysis, hypotonic, hypertonic, isotonic solutions; pressure; Dessication; pH; Surface tension; Ultrasonic waves; Radiations - UV, Ionising, α , β , gamma, x-rays. Effects of environment on bacteria: temperature, pH, UV-light, Dessication, Osmotic pressure, Surface tension.

Chemical agents: Acids and alkalis, reducing/oxidizing agents (Phenols, cresols, alcohols, halogens, heavy metals, mercury compounds, aldehydes, quarternary ammonium compounds); Gases - formaldehyde, ethylene oxide, β -propiolactone.

Sterilization methods:

Physical methods: Heat: dry / moist heat, mechanism of sterilization. Instruments used and their operation; Pasteurization, Autoclaving, Inspissation, Tyndallization; TDP, TDT, Factors affecting sterilization; sterility checks & standards. Radiations: ionising and UV radiations; mechanisms of sterilization. Filtration: Bacteria-proof filters for sterilizing liquid (Asbestos, Sintered, glass, membrane) and air (glass wool and HEPA). Disinfection - Properties of an ideal disinfectant, evaluation of disinfectants - inhibition coefficient, phenol coefficient

III Microbial Physiology**Enzymes**

Definition; protein nature, active site, specificity, Holoenzyme, Apoenzyme, Coenzyme, Cofactors, Prosthetic group, monomeric, oligomeric and allosteric enzymes. Classification and nomenclature of enzymes with examples. Specific activity of enzymes, factors affecting enzyme action (Substrate concentration, Enzyme concentration, Temperature, pH, Activators, Inhibitors (Competitive and non-competitive). Enzyme Kinetics: Michaelis-Menten equation (derivation), Lineweaver- Burke plot (derivation). Regulation of enzyme activity (Feedback inhibition, isofunctional enzymes, concerted, sequential). Isolation and purification: Homogenization, salting-in & salting-out, Dialysis, Ammonium sulphate precipitation, dialysis, specific activity. Chromatography (Paper, TLC, Column-gel filtration), Ultracentrifugation & Electrophoresis. Chromatographic separation of sugars/ aminoacids by paper. Chromatographic separation of sugars/ aminoacids by TLC. Detection of bacterial enzyme activity: amylase, caseinase, catalase, dehydrogenase, nitratase, urease, gelatinase, lipase, desulfurase, pectinase, cellulase.

Coenzymes: Definition, Coenzymes derived from vitamins: TPP (Thiamine), FMN, FAD (Riboflavin), Pyridoxal phosphate (Pyridoxine), cobamide coenzyme (Cyanocobalamine), NAD, NADP (Niacin), THFA (Folic acid), CoA (Pantothenic acid), Biotin; Functional role with examples in metabolism.

Metabolism:

Concept of Metabolism: Anabolism, Catabolism; Energetics. Carbohydrates: Biosynthesis of carbohydrates: Glycogen, Peptidoglycan. Major pathways in heterotrophs & regulation: EMP, HMP, ED pathway, TCA pathway (Amphibolic pathway, Anapleurotic reactions), Glyoxylate cycle, Alcohol fermentation, Mixed Acid Fermentations - Homo- & Hetero-fermentative pathways.

Lipids: Biosynthesis of Lipids, Poly beta-hydroxybutyric acid. Beta and omega-oxidation. Biosynthesis of saturated fatty acids: reactions of fatty acid synthetase system – palmitic acid.

Proteins: Digestion of proteins and peptides; Flow sheet of amino acid oxidation, Transamination, Deamination, Decarboxylation; Stickland reaction.

Nutrient Transport:

Types of mechanisms of solute transport: passive diffusion, facilitated diffusion, active transport, group translocation. Endocytosis: Phagocytosis, Pinocytosis.

Bacterial bioluminescence:

Definition, mechanisms, significance & applications. Isolation of bioluminescent bacteria.

IV Microbial Genetics

Concept of gene

Chromosome, chromosome/DNA as carrier of gene. Structure of DNA : purines / pyrimidines, nucleosides / nucleotides, Watson -Crick model; Prokaryotic DNA (Circular DNA, Supercoiling, Palindromic); Eukaryotic DNA (Repetitive sequences, split genes, nucleosomes), mitochondrial and chloroplast DNA; RNA: mRNA, rRNA, tRNA. Electrophoretic separation of nucleic acids.

Replication of DNA

Modes of replication - Conservative, semi conservative (Meselson- Stahl experiment) and dispersive. Processes and enzymes involved in replication.

Transcription

Transcription in prokaryotes and eukaryotes, post-transcriptional modification - RNA splicing, formation of mRNA, RNase H activity; Ribozyme

Translation

Concept of genetic code, codon / anticodon, properties, Wobble hypothesis, start and stop codons, nonsense codons; Ribosomes as sites of protein biosynthesis; amino acid activation and specificity; Initiation, Elongation, Termination; post-translational processing & modification, Inhibitors of protein synthesis; differences between prokaryotic and eukaryotic translation process.

Gene expression and regulation

Induction and repression; catabolite repression; lac operon - structural and regulatory genes, positive and negative regulation, *trp* operon.

Gene transfer mechanisms with schematic illustrations and significance:

1. Transformation - Griffith's experiment; Avery, MacLeod and McCarty's experiment; competence factor.
2. Transduction - Davis U-Tube experiment. Lytic and lysogenic cycle, Generalized, Specialized, Complete & abortive Transduction.
3. Conjugation, gene transfer by F⁺ strains, Hfr donor, F-prime state, gene mapping.