

Microbiology

COURSE MODULE

SR	TOPICS(Respective no. of classes)	Total allotted Classes	NAME OF concerned teacher
PART I			
Paper I. Diversity of microorganism (100 Marks)			
Group A Basic knowledge on Prokaryotic microorganisms (50 Marks)			
1.	History and development of microbiology; contributions of Leeuwenhoek, Koch, Pasteur, Jenner and Fleming; scope of microbiology	10	
2	Staining and staining techniques: Classification of stain, principles of staining, negative, simple and differential staining.	6	
3	Principles and modern approaches of bacterial taxonomy. Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese. Outline classification of bacteria and archaea as per 2 nd edition of Bergy's Manual.	14	
4.	General characteristics, economic importance and example of representatives from the following Phylum- Proteobacteria (Chlamydia & Rickettsia); Low G + C Pharmicutes (Mycoplasma), Actinobacteria, Cyanobacteria.	26	
5.	Morphology and structure: Bacterial morphology- shape size structure, chemistry and function of cell wall, membrane, capsule, pili, flagella, plasmid, and bacterial chromosome.	12	
6.	Resting structure: Endospore- structure, formation, germination, resistance.	6	
7.	Reserve materials- carbon and phosphate reserve, cyanophycin.	6	
8.	Cytoplasmic inclusions: Chlorosome, magnetosome, carboxysome, gas vesicles, ribosome.	8	
9.	Archaea: General characteristics(1), major groups(3), economic importance(1).	5	DN
Group –B : Eukaryotic Microorganisms and Virus (50 Marks)			
1.	Algae: Classification of Lee (2009), General characteristics, Plant body types and reproduction of the following groups- Chlorophyta, Xanthophyta; Economic uses of algae.	12	
2.	Fungi: Classification of Ainsworth, general characteristics, plant body types and reproduction of the following groups- Phycomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Economic importance of Fungi.	12	
3.	Protozoa-: Classification of Levine (up to subkingdom), general characteristics, reproduction. Economic importance.	8	
4.	History and development of virology(2), structural organization and chemistry of viruses(4).	6	DN
5.	Classification of virus according to ICTV (2). Virus assay	5	DN

	(Pluck and Pock test) (3).		
6.	Lytic cycle of bacteriophages, with reference to E. coli and T4.	2	DN
7.	Lysogeny- lysogenic conversion, induction and significance	3	DN
8.	Prion(1), viroids(1), virusoids(1), satellite virus(1)	4	DN
Paper-II- General Biochemistry (50 Marks)			
1.	Physicochemical Properties of water: Structure of water molecule, physical properties, ionic product of water(2), pH & pK – their definition, relation to acids, bases & buffers in biological system(3). Electrostatic bond, hydrogen bond, hydrophobic bonds & Van der Waals interactions(2).	7	DN
2.	Carbohydrates: Definition, classification, and structural concepts of triose, tetraose, pentose and hexose sugars(2), disaccharides, (sucrose, lactose and maltose) (1),. Asymmetric carbon atoms, mutarotation, and isomerism(2). Important derivatives and properties of mono-saccharides (glycosides, sugar acids, deoxysugars, aminosugars). Polysaccharides and glycol-proteins(2).	7	
3.	Amino acids and peptides; Classification(1), acid base properties, titration curve of amino acids (neutral, acidic and basic aminoacids) (2), reaction of aminoacids(1), peptide linkage and polypeptides(1).	5	
4.	Proteins: Classification (only function based) (1), primary, secondary and tertiary and quaternary (only domain and subunit) structure(5); Protein turn over(1)	7	
5.	Enzymes: general characteristics(1), nomenclature, classification(2), enzyme kinetics, Michaelis- Menten equation and Lineuaver Berck Plot(2), co-enzymes and their function(1). Competitive, non- competitive and uncompetitive inhibition of enzyme activity(2). Allosteric inhibition(1). Outline idea of isozyme, abzyme, ribozyme and zymogen(1).	10	DN
6.	Lipids: Nomenclature, classification (only structure based) and properties of different types of lipids(3). General classification of fatty acids(1); chemical reactions of saturated and unsaturated fatty acids(2). Lipid micelles, lipoproteins, liposomes, bilayer formation(2).	8	
7.	Nucleic acids: Purine, pyrimidine bases, nucleosides and nucleotides(1). Structure, properties and types of DNA and RNAs(5).	6	DN
Paper-III (PRACTICAL); Full Marks-50			
	1. Details of microscope and its function: Standardization, Magnification 2. Preparation of basic liquid media(broth) and solid media for the routine cultivation of bacteria (Milk, Nutrient broth/agar, Davis Migolis Medium) and fungi (Lemon extract, Saboroud dextrose agar/broth, Zapek Dox medium) 3. Preparation of slant and stab 4. Pure culture technique: Spread plate, pour plate, streak plate 5. Isolation and enumeration of bacteria and fungi from natural		DN

	<p>sources: soil, air and water</p> <p>6. Morphological study of eukaryotic/ prokaryotic cell types (from permanent slides): Bacteria- Bacillus sp. Staphylococcus sp. Gloeotrichia sp., Nostoc sp. 5 Algae- Zygnema, Oedogonium, Chlamydomonus, Spirogyra; Fungi- Rhizopus, Penicillium, Agaricus, Yeast; Protozoa- Paramoecium, Euglina</p> <p>7. Simple staining of microbes and study of cell types (work out specimen-curd and root nodule, Spirogyra, Penicillium, paramoecium)</p> <p>8. Differential Staining: Gram's staining, Endospore staining and Acid-Fast staining</p> <p>9. Chemical estimation of Sugar (DNS method), Amino Acids (ninhydrin method), Protein (Lowry method), DNA (diphenyl amine method), RNA (Orcinol method)</p>		
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PART II

Paper IV (Theory)- Physiology of Microorganisms Full Marks: 100

Group A: growth and Nutrition of Microorganisms Full Marks 50

1.	Microbial Nutrition: Nutritional types (Definitions and examples) - Photoautotrophs, Photo- organotrophs, Chemo-lithotrophs (ammonia, nitrate sulphur, hydrogen, iron oxidizing bacteria), Chemo-organotrophs; effects of oxygen on growth, Classification on the basic of oxygen requirement and tolerance	12	
2.	Media type and Preservation: Components, criteria and role of macro and micro-nutrients. Natural, Synthetic, Complex, Selective media & Differential Media. Preservation of Microorganisms.	16	
3.	Bacterial Growth:Growth phases, Generation Time, Kinetics of Growth, Batch Culture, Continous culture, Synchronous culture, Chemostat, Turbidostat, Diauxic Growth, Enrichment Culture. Physical factors influencing growth: Temperature, PH, Atmospheric Pressure, Salt Concentration, Chemical factors: heavy metal (copper), surfactants (Triton X 100 and SDS).	20	
4.	Control of Microorganisms: Physical methods- heat (dry and wet heat) , filtration, radiation, chemical methods: Ethanol, phenolics, ethylene oxides, formaldehyde, halogens.	12	
5.	Bacterial Photosynthesis:Photosynthetic microorganisms; Bacterial photosynthetic apparatus; Pigments; Bacterial photosynthesis mechanism and differences from Eukaryotic photosynthesis	17	
6.	Biological Nitrogen Fixation:Symbiotic and Non-symbiotic nitrogen fixation; Nodule formation in leguminous plants; Biochemistry/mechanisms of nitrogen fixation; Component of nitrogenase system	7	
7.	Chemotherapeutic agents: Sulphonamides, Antibiotics, Mechanisms of action and antimicrobial spectrum of Penicillin, Streptomycin, Tetracyclines, Chloramphenicol,	8	

	Nalidixic acid and Metronidazole. Drug resistance-phenomenon and mechanism		
Group B: Microbial Metabolism Full Marks 50			
1.	Carbohydrate Metabolism: Glycolysis(1), TCA cycle(1), Pentose Phosphate Pathway(1), Entner Doudroff Pathway(1), Stickland-reaction(1), Phosphoketolase pathway(1), Gluconeogenesis(1), Glycogen Synthesis(1) and lysis(1), Glyoxalate Cycle(1)	10	
2.	Energy Production: Substrate level Phosphorylation(1), Electron Transport System(2), Phosphotransferase system, Energy Yield and ATP generation sites(3).	6	
3.	Anaerobic respiration (Nitrate respiration)(2), Fermentation (Homolactic and Heterolactic Fermentation)-their utility(3).	5	
4.	Amino acid and Protein Metabolism: Concept of endo- and exo-peptidase, Transamination, Deamination, Transmethylation and decarboxylation(4). Biosynthesis of Aminoacid (Aspartate family)(2).	6	
5.	Lipid Metabolism: Detailed account of beta-oxidation of even and odd number, saturated and unsaturated fatty acids(5), biosynthesis of fatty acids(2), degradations of fatty acids(2)	8	
6.	Protein Biosynthesis- Genetic Code: Nature(1), Character(1), Deciphering of Code(2), Wooble Hypothesis(1), Universality & non universality of genetic code(1), Non Watson & Crick Codes(1). Transcriptional Mechanism (Initiation(1), Elongation(1), Termination(1)), Post Transcriptional modification of mRNA in Eukaryotes (only basic idea) (2). Genetic Code and its Characters. Translation including phenomena of Initiation(1), Elongation(1), Termination(1).	15	DN
Paper V -Biophysical Chemistry & Bioinformatics FM : 50			
1.	Thermodynamics : Laws of thermodynamics, concept of free energy(2), entropy & enthalpy(2), standard free energy change & high energy bond(3).	7	
2.	Biophysical Principles: Osmosis, osmotic pressure, Donan equilibrium, diffusion potential, diffusion coefficient, endocytosis & exocytosis, gradient of chemical potential as driving force in transport, membrane potential & ionophores.	5	
3.	Microscopy: General principles of optics(1), compound microscope(1), dark-field(1), bright-field(1), microscopy; concept of phase contrast(1), electron microscopy (SEM and TEM) (2)	7	DN
4.	Spectrophotometry: Concept of electromagnetic radiation, Beer-Lambert's Law, derivation & deviation(2). Extinction coefficient, absorptivity & working principle of Colorimeter & Spectrophotometer(2). Application of UV-VIS Spectrophotometer(2).	6	
5.	Fundamental of Radioactivity: Radioactive & non radioactive isotopes, Laws of Radioactivity, Half life & Average life(2), types of radiation (α , β , γ radiations)(1) application of radioactive isotopes in biology(2).	5	
6.	Chromatographic Techniques: Principle (1) & application of	6	DN

	Paper, Thin Layer (TLC) (1), Column, Gas- Liquid(1), High Performance Liquid (HPLC) (1), Ion-exchange, Absorption & Affinity Chromatography. (2)		
7.	Electrophoresis: Principle & application of Gel Electrophoresis(2), Iso-electric Focusing(1) & Immuno-electrophoresis(1)	4	DN
8.	Bioinformatics- definition and its application in Microbiology. (1)Different types of sequence DADTABASE (EMBL, Gene Bank, SWISPROT) (1); Concept of sequence alignment (pair wise and multiple) and their importance(1). Search engines- definition and importance(1). Definition, concept and importance of phylogenetic tree(1).	5	DN
9.	Sample and population: Sampling methods, construction of histogram, interpretation of histogram, sample mean, sample standard deviation, the normal distribution, the mean, mode, median and standard deviation of the normal distribution, Uncertainties in estimation of a mean. Testing of hypothesis, T-test and Chi-square test.	5	
Paper (Practical) VI FM : 50			
	<ol style="list-style-type: none"> 1. Enrichment culture technique – enrichment of spore formers, N₂ fixer, Cellulose decomposer & Photosynthetic Bacteria. 2. Study of bacterial growth by optical density. 3. Study of bacterial growth by cell number counting (Breed Method Haemocytometer Method), & determination of generation time. 4. Study of different factors affecting growth (Temperature, pH, Osmotic pressure, Heavy metals (copper using coper sulphate), Different chemicals- combination of sugar (glucose + lactose i.e. di-auxic growth) and Vitamin B₁₂. 5. Biochemical Tests- Catalase, Protease, Indole Production, VP Test, Amylase Test, Acid- Gas production, MR, Citrate utilization,, nitrate reductase test. 6. Chromatography – TLC & Paper Chromatography of Sugar & Amino acids. 7. Isolation of <i>Rhizobium</i> from root nodule. 8. Control of microbial growth – moist heat, dry heat and UV irradiation. 		
PART III			
Paper VII (Genetics of Microorganisms & Medical Microbiology) FM: 100			

Group A: Microbial Genetics & Gene Manipulation: FM: 50			
1.	Bacterial Mutation: Spontaneous & induced Mutation(1) of Bacteria, Fluctuation Test(1), Types of Mutants (auxotrophs, conditional mutants) & their selection(1), Molecular basis of Mutation(2), Mode of action of Mutagen(1).	6	DN
2.	Outline of Mendelian genetics: Laws, Test cross, Back cross, deviations (incomplete dominance, hypostasis, epistasis, complementation)	13	
3.	Genetic recombination in bacteria: Transformation(2), Conjugation- F ⁺ , F ⁻ , Hfr & F' strain(2), Transduction(1), Generalised & specialized types(2).	7	
4.	Concept of Central Dogma, DNA replication: Meselson-Sthal Experiment as Evidence for semi-conservative replication(1), Rolling Circle Model and Theta Model (bi-directional) (2). Recombination in viruses, packaging & concatamer(1).	4	DN
5.	Replication of plant and animal viruses; differences between DNA and RNA viruses(1), replication of viral DNA(2) and RNA(2). Genomic organization and mode of reproduction of Retroviruses(1), SV40(1), Polio virus(1)	8	DN
6.	Gene Regulation: Positive & negative control(2), Inducible system & repressible system(2). Lac – operon, Catabolite repression, Lysogenic control(2).	6	
7.	Genetic Engineering: Principles(1), Vectors (Plasmid based- pUC & pBR 322, YAC, BAC, λ phage, cosmid) (2), Enzymes(1), Gene transfer(1), Methods of Screening (blue-white) (1), Application in Agriculture, Health & Industry(1).	7	DN
8.	Molecular Bio-assay Technique: RFLP(1), Southern Blotting(2), Northern Blotting(1), western Blotting Technique(1), PCR Technique (2) (general and reverse transcriptase).	7	DN
Group B: Microbial Pathogenicity & Immunity FM: 50			
1.	Predominant Normal Microbial Flora of Human Body: Skin, Respiratory Tract, gastrointestinal Tract, Urinogenital Tract.	8	
2.	Mechanism of Bacterial Pathogenicity: Invasiveness, Entry, colonization, Growth, Mechanism of damage of Host cell, Production of exo & endo Toxin – definition & general characters. Neuro-toxin, Entero-toxins & Cyto-toxins	11	
3.	Common Microbial Diseases: Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of following diseases: i) Bacterial- Typhoid(2), Staphylococcal Food Poisoning (2) ii) Viral- AIDS(2) iii) Fungal- Candidiasis (2) iv) Protozoal- Malaria(2).	10	DN
4.	Immunity: a) Fundamental concepts of Immune System (2) b) Immune elements – Types, characteristics & function of T-cells, B-cells, macrophages, NK-cells.(4) c) Types of Immunization – Active & passive (Characteristics & Function).(2) d) Types of Immunity: i) Humoral T cell dependent & T cell independent mechanisms . (3) ii) Cell mediated mechanisms. (2)	25	

	e) Immunoglobulins : Types, Structure & Function.(3) f) Antigen : Types & characteristics (2) g) Haptens: Characteristics& Function. (1) h) Ag-Ab reaction – agglutination, precipitation, opsonisation, lysis, neutralization. (3) i) Complement fixation pathways. (2) j) Immunological techniques- ELISA (1)		
Paper (Ecology & Application of Microorganisms) – VIII FM-100			
Group A: Environmental Microbiology: FM: 50			
1.	Microbial Participation in natural cycles:Elements of the cycles (N, P), interrelationships of microorganisms in soil & natural ecosystems	5	
2.	Waste as Resources:Organic compost, green manure, biogas production .	5	
3.	Potability of water: Microbial assessment of water quality, water purification, Coli form test.	4	
4.	Biological waste water treatment:Waste water characteristics, BOD, COD, Secondary treatment (Activated Sludge, Oxidation Pond, Trickling filter).	8	
5.	Microbial Leaching:Copper, Uranium	4	
6.	Bioremediation or Biodegradation: Microbial tolerance to heavy metals (Pb, Hg), Mechanisms of resistance, remediation of soil by microbes. Microbial plastics & biodegradation of petroleum. Brief idea about bio-magnification.	10	
7.	Biofertilizers:Types (Rhizobium, Phosphate solublizer, BGA & VAM), Production & application of Biofertilizers. Importance of Biofertilizers in Agriculture	8	
8.	Rhizosphere, Phyloplane:Types of Microorganisms & their interactions, Importance.	6	
Group B: Food & Industrial Microbiology: FM: 50			
1.	Food production by Microorganism:Fermented dairy products (Cheese, Yogurt), Fermented Food (Saurkrauts, Ensilage, Single Cell Protein), Probiotics- general idea.	9	
2.	Role of Microorganisms in spoilage of Food:Meats, egg , fruit and vegetables.	6	
3.	General principle of food preservation:Low temperature, High temperature, Dehydration, Radiation, Pasteurization, Chemical base preservation	6	
4.	Milk Microbiology:Milk as a source of microorganisms, Types of microbes in milk, Pasteurization of milk, Testing of milk	6	
5.	Fermenter:Fermenter operation, sterilization, aeration,agitation, control of temperature and foaming.	6	
6.	Industrial Microbiological products:Alcohol and alcoholic beverages (beer), organic acids (lactic acid), antibiotic (penicillin), amino acid (lysine), vaccine (Hep-B) & Vit B12 production.	9	
7.	Application of Genetic engineering in Microbiology:Biodegradation of xenobiotics & toxic wastes,	8	

	Production of Chemicals (organic acids, steroids) & fuels (Ethanol), Bioinsecticides (Bacillus thurigiensis & nuclear polyhedrosis viruses).		
Paper IX (Practical) FM: 100			
	<p>Antibiotic (Penicillin & streptomycin) assay by agar cup method using one Gram positive and one Gram negative bacteria..</p> <p>2. Determination of MIC of antibiotic (penicillin/ streptomycin)</p> <p>3. Examination of urine by culture & isolation of Human pathogen (bacteria) & determination of antibiotic sensitivity pattern of the isolated bacterial strain.</p> <p>4. Isolation & characterization of Bacteria & fungi from rotten food- bread & carrot.</p> <p>5. Determination of microbial population in water by filter disc method.</p> <p>6. Microbiological examination of water (drinking water, supply water & pond water).</p> <p>k) Presumptive test ii) Confirmatory test iii) Completed test for coliform iv) Determination of MPN index v) IMViC reaction</p> <p>7. Methylene blue reduction test for milk.</p> <p>8. Plaque assay for coliphage.</p>		
PAPER (PRACTICAL)- X Full marks – 100			
	<p>1. Isolation of mutants of bacteria by UV exposure.</p> <p>2. Isolation of amino acid auxotrophic mutant by replica plating technique (Penicillin enrichment technique)</p> <p>3. Isolation of Ampicillin resistant mutants by selection by gradient plate method..</p> <p>4. Blood grouping</p> <p>5. Isolation of plasmid, chromosomal DNA by standard method.</p> <p>6. Agarose Gel Electrophoresis.</p> <p>7. Cultivation of edible mushroom</p> <p>8. Determination of Thermal Death Point(TDP) of a bacteria</p> <p>9. Widal Test (Determination Ab titers using kit)</p> <p>10. Production of alcohol by Yeast and estimation of alcohol.</p> <p>11. Dot ELISA</p> <p>12. Quantitative estimation of alpha-amylase, effect of PH and temperature of alpha-amylase activity.</p>		