UNIVERSITY OF CALCUTTA

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Ref No. CUS/16 /17
Dated the 25th January, 2017

To
The Principals/T.I.C.
of all the Undergraduate Colleges
offering B.Sc. (Honours) in Microbiology
affiliated to the University of Calcutta

Sir/ Madam,

The undersigned would like to forward you the Draft Syllabus for Microbiology (Honours), to be implemented from the academic session 2017-2018 to get feedback from the Department of Microbiology in your college.

You are requested to send your feedback within 15th February, 2017.

In this regard you may send your observations/ suggestions to the Department of U.G. Councils, C.U. or through email (u.g.councilsc.u@gmail.com) or you may contact **Prof. Sanjay Ghosh**, Department of Biochemistry, C.U. (Mob:9433394502; email: sgbioc@caluniv.ac.in and sgbioc@gmail.com).

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Yours faithfully,

25.1.17.

(Milan Kr. Pal)
O.S.D., C.U.

UNIVERSITY OF CALCUTTA

DRAFTSYLLABUS

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THREE-YEAR HONOURS
DEGREE COURSE OF STUDIES

MICROBIOLOGY

2017

Syllabus for Microbiology Honours

Part I: 200 Marks

Paper I: 100 Marks

Group A: Biomolecules

Unit I

1. Carbohydrates
2. Amino acids

Unit II

1. Proteins
2. Nucleic Acids
3. Lipids

Group B: General Microbiology

Unit I

1. The evolution of microorganisms and microbiology
2. Fundamentals of Taxonomy
3. Stains and Staining techniques
4. Bacterial morphology and subcellular structures

Unit II 1

1.Eukaryotic microbes
2. Microbial nutrition
3. Bacterial growth
4. Control of growth of microorganisms

Paper II: Marks

Group A: Environmental Microbiology and Biophysical Chemistry

Unit I

1. **Air Microbiology**
2. **Soil Microbiology**
3. **Biogeochemical cycles**

Unit II

1. **Fundamentals of thermodynamics and bioenergetics**
2. **Fundamentals of Spectroscopy**
3. **Physical and chemical properties of water**
4. **Microscopy**

Group B: Practical

UNIT I

1. **Microbiology: Good Laboratory Practices and Biosafety.**
2. **To study the principle and applications of important instruments.**
3. **Preparation of culture media.**
4. **Cultivation of Micro organisms.**
5. **Staining techniques for examination of microorganisms**

UNIT II

1. **Qualitative tests of biomolecules**
2. **Separation of aminoacids by Thin Layer Chromatography.**
3. **Estimation of amino acid by formol titration.**
4. **Internal assessment**

PART II; 200 Marks

Paper III: 100 Marks

Group A: Molecular and Cellular Biology

Unit I

1. Replication, Transcription and Translation in Prokaryotes

Unit II

1. Eukaryotic cell biology

Group B: Metabolism and Bioenergetics

Unit I

1.Enzymes
2. Amino Acid Metaboilsm

Unit II

1.Carbohydrate metabolism
2. Purine and Pyrimidine metabolism
3. Lipid metabolism

Paper IV: 100 Marks

Group A: Food Microbiology, Water Microbiology and Industrial Microbiology

Unit I

1. Food Microbiology
2. Water Microbiology
3.Industrial Microbiology

Unit II

1. Biometry

2. Instrumentation /Techniques for Characterization of biomolecules
3. Fundamentals of Radioactivity

Group B: Practical

UNIT I

1. Micrometry and Enumeration of microbes
2. Isolation of pure culture from natural sources:
3. Growth curve of bacteria
4. Assay of antibiotics
5. Determination of Minimal Inhibitory Concentration (MIC) of antibiotic

UNIT II

1. Water microbiology
2. Milk microbiology
3.Study of protozoans using permanent mounts/photographs.
4. Internal assessment

PART III:400 Marks

Paper V: 100 Marks

Group A: Microbial Genetics

Unit I

1.Mendelian genetics
2. DNA, Gene and Chromosomes
3. Linkage and Crossing over
4. Genetic Exchange

Unit II

1. Mutation and Repair
2.Recombination

Group B: Recombinant DNATechnology and Bioinformatics

Unit I

1.Recombinant DNA Technology
2. Genomics and Bioinformatics

Unit II

1. Mycology

Paper VI:100 Marks

Group A: Medical Microbiology and Virology

Unit I

1.Medical Microbiology

Unit II

1. Virology
2. Microbial community

Group B: Immunology

Unit I

1.Introduction: overview of the Immune system
2.Cells and organs of Immune system
3.Types of Immunity
4.Antigens

Unit II

1. Immunoglobulins
2. Antigen - Antibody interactions
3. Complement
4.**Hypersensitivity: definition, types, examples.**
5. Vaccines

Paper VII (Practical):100 Marks

UNIT I

1. Isolation and characterization of one industrially important enzyme (amylase) and immobilization of amylase producing cells.

2. Determination of Km, Vmax and pH optima, effect of activator, inhibitor of alkaline phosphatase.

3. Industrial/Institutional visit and report preparation

UNIT II

1. Protein estimation by Lowry method.
2. Absorption spectra of DNA and protein, hyperchromic shift of DNA.
3. Separation of protein molecules by SDS gel electrophoresis.
4. Internal assessment

Paper VIII (Practical):100 Marks

UNIT I

1. Antigen-Antibody reaction:
a) Agglutination (blood typing method)
b) Ouchterlony's agar double diffusion method (Dilution study and study of patterns)
c) Single radial immunodiffusion (Mancini's method),
d) Immunoelectrophoresis.

2. Restriction digestion of lambda and plasmid DNA.
Visualisation of the DNA fragments by Agarose gel electrophoresis.

UNIT II

1. Isolation of plasmid-DNA (E.coli - DH 5α)
2. Agarose gel electrophoresis.
3. Quantification of plasmid DNA and checking the purity.
4. Isolation of Genomic DNA andvisualisation of the DNA fragments by Agarose gel electrophoresis.
5. Transformation of *E. coli* using plasmid DNA by $CaCl_2$ method.
6. Internal assessment.

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THREE-YEAR HONOURS
DEGREE COURSE OF STUDIES

MICROBIOLOGY

2017

PART –I: 200 marks

Paper I

Group A: Biomolecules (50 marks)

UNIT I

1. **Carbohydrates(12)**
   Definition, classification**,** properties and structural concept of: Monosaccharides: Hexoses (only Glucose, fructose), Pentoses (Ribose, Ribulose, Xylose) Disaccharides: Sucrose, Lactose, Maltose Amino Sugars: Glucosamine, Muramic Acid, Sialic acid. Inversion (hydrolysis) of cane sugar.Chemical reactions of monosaccharides (glucose & fructose i.e., aldose and ketose) with $HN0_3$, Br_2 - water, $HI0_4$, Phenylhydrazine.Glycosides**,** Principle of chemical estimation of sugar.Anomeric effect (Methylation effect). Polysaccharides: Chemical structure of Starch (α- amylose, amylopectin), glycogen & cellulose, cell wall..Smith degradation and enzymichydrolysis of α-amylose & amylopectin. Projection formula (Fischer & Howarth); Pyranose and Furanose forms of carbohydrates;Isomers: anomers, epimers. Stereochemistry of cyclohexane: idea of axial & equatorial bonds (related to chair form conformation) for representing the structures of carbohydrates in chair form. Mutarotation and its mechanism.
2. **Amino Acids (13)**
   Definition, classification, structure, stereochemistry of amino acids;General concepts on: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature, Physico-chemical properties (Ionization & Biuret reaction) of amino acids. Amphoteric molecule, Zwitterion, pK values; Isoelectric point, Electrophoresis, Formol titration of Glycine (only reaction & principle). Reaction with Ninhydrin, FDNB, Dansyl&Dabsyl chloride, Fluorescamine, Van-slykes reaction.Reactions of carboxyl & amino groups.Synthesis of Glycine (Pthalimide, Strecker and Haloester). Separation of amino acids by-Ion-exchange, Gel filtration, Paper Chromatography and Thin layer Chromatography.

UNIT II

1. **Proteins (10)**
   Peptides: peptide bond, biologically important peptides (glutathione, oxytocin-important functions). Classification (Primary, Secondary, Tertiary, Quaternary-definition, examples) Forces that stabilize structure of proteins: H-bonds, hydrophobic interaction, electrostatic attraction, Van der Waal's interaction, dipole-dipole interaction. Types of proteins: i) Fibrous (α -helix, β - sheet, e.g. collagen): definition and structure. ii) Globular (Haemoglobin, Myoglobin): definition &structure **,** examples. iii) Simple proteins and conjugated protein: definition & examples—physical denaturation and renaturation.

2. **Nucleic acid (7)**

Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). Chemical Properties: Hydrolysis (acid, alkali), enzymatic hydrolysis of DNA. General structure and types of RNA (tRNA, mRNA, rRNA, catalytic RNA, micro RNA, hn and sn RNA). Viscosity, Buoyant density.Hyperchromic effect.Cot curve, Tm.

3.Lipids (8)

Definition, nomenclature, classification - (simple, complex, derived lipids - structure & example) phospholipids, glycolipids, - (structure, composition); hydrolysis, saponification, saponification number, Iodine number, acetylation, acetyl number, volatile fatty acid number - definition and related problems, Isomerism - cis-trans isomerism. Fatty acids: Saturated (palmitic acid, stearic acid), unsaturated (oleic acid): Structure of free fatty acids (example only). General chemical reaction of fatty acids - esterification.Hydrogenation and halogenations.Rancidification of Oil.

Suggested textbooks:

- 1.Finar, IL. Organic Chemistry, Part I and Part II
- Lehninger, Stryer, Voet and Voet, Debajyoti Das, Biochemistry
- Morrison Boyd, Organic chemistry
- Solomons,Organic chemistry
- Subroto Sengupta, Organic Chemistry

Group B: General Microbiology (50 marks)

UNIT I

1. The evolution of microorganisms and microbiology (5)

A brief idea of the members of the microbial world

Microbial evolution- evidence for the origin of life, preliminary concept of RNA world, endosymbiotic hypothesis.Basic concept of microbial species

Theory of abiogenesis and biogenesis- Pasteur's experiment with swan-necked flask

Germ theory of disease and Koch's postulates, its drawbacks and Molecular Koch's Postulates.Discovery of antibiotics- contribution of Alexander Flemming

Microbial ecology – contribution of Winogadsky and Beijerinck

2. Fundamentals of Taxonomy(5)

Whittaker's five-kingdom classification- classification basis, major characteristics of the kingdoms, drawbacks of the classification scheme.Three domain classification scheme of Carl Woese- classification basis, major characteristics of the kingdoms, drawbacks of the classification scheme. Morphological features of Eubacteria, Archaebacteria and Eukarya

Outline of Principles of Bacterial taxonomy-Phenetic,Cladistic and Polyphasic approach, Numerical taxonomy, Bergey's Manual

3. Stains and staining techniques (5)

Definition of stains and their components- auxochrome, chromogen and chromophore

Physical basis of function of stainsClassification of stains on the basis of their structures. Simple, differential and negative staining methods.Mordants and their functions.Gram staining and its mechanism.Endospore staining.Capsule staining.Acid fast staining.Flagella staining

4. **Bacterial morphology and subcellular structures (10)**

General features of a typical bacterial cell- its shape, arrangement and size.

Bacterial cell envelope- chemical composition, structural features and functions of bacterial plasma membrane (eubacterial and archaebacterial), cell wall including Gram negative outer membrane (porins, periplasm, teichoic acid, protoplast, spheroplast, cell wall less bacteria, archaebacterial cell wall), capsules and slime layers, S-layer.

Bacterial cytoplasm- chemical composition, structural features and functions of bacterial cytoskeleton, bacterial inclusion bodies, bacterial ribosomes, nucleoid, plasmids.

Bacterial cell external structures- chemical composition, structural features and functions of bacterial flagella, pili and fimbriae, flagellar movements (swimming, swarming), spirochaete motility, twitching and gliding motility, chemotaxis.

Bacterial endospores- location, size, structure, resistance, sporulation process and germination process, exospores and cysts- structural and functional comparison.

UNIT II

1. **Eukaryotic microbes (5)**

   General characteristics, vegetative and reproductive structures of fungi (yeasts and molds), fungal classification with example.Algae-classification with example (special emphasis on cyanobacteria). Protozoa (Giardia, Plasmodium and Entamoeba)

2. **Microbial Nutrition (7)**

   Nutritional types (definition and example)- photoautotroph, photoorganotroph, chemolithotroph (overview and example of ammonia, nitrite, sulfur, hydrogen and iron oxidizing bacteria), chemoorganotrophs, copiotrophs, oligotrophs and myxotrophs. Different types of growth media for laboratory culture of microorganisms (defined, undefined, selective, differential, enriched media and example, anaerobic culture media).Classification of microorganisms on the basis of oxygen requirement and tolerance.

3. **Bacterial growth (7)**

   Characteristics of bacterial growth phases, generation time, kinetics of bacterial growth, growth rate constant, semilogarithmic pattern of bacterial growth curve, cryptic growth, diauxic growth,

   Measurement of bacterial growth (total count and viable count, pour plate and spread plate technique, serial dilution- its merits and demerits in culturing microorganisms, pure culture isolation). Batch culture and continuous culture; synchronous culture

(definition and brief description).Physical factors influencing bacterial growth-temperature, pH, osmotic pressure, salt concentration; molecular adaptation of microorganisms to thermophily, psychrophily and osmophily.

4. Control of growth of microorganisms (8)

General concept of sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agents (definition, application and example)

Physical methods of sterilization and disinfection – dry heat (incineration, hot air oven), moist heat (autoclave, fractional sterilization), filtration, radiation (ionizing and non ionizing)

Chemical methods of sterilization and disinfection – alcohol, acid, alkali, halogens, heavy metals, phenol and phenol derivatives, dyes, formaldehyde, ethylene oxide, detergents, Quarternary ammonium compounds; assessment of chemical disinfectants, phenol coefficient- definition and method of determination, factors affecting phenol coefficient

Chemotherapeutic agents- growth factor analogues (sulfonamides), antibiotics(penicillin, streptomycin, tetracyclin, erythromycin, chloramphenicol, nalidixic acid and metronidazole).Definition and types on the basis of their mode of action.

Suggested Textbooks:

- Atlas, RM., Principles of Microbiology, 2nd edition, McGraw Hill
- Willey, JM., Sherwood, LM., Woolverton, CJ., Prescott's Microbiology, 9th edition, McGraw Hill
- Madigan, MT., et al., Brock Biology of Microorganisms, 13th edition, Benjamin Cummings
- Black, JG., Microbiology-Principles and explorations, 7th edition, John Willey & Sons, Inc.
- Slonczewski, JL., Foster, JW., Gillen, KM., Microbiology-an evolving science, 2nd edition, Norton
- Salle, AJ., Fundamental Principles of Bacteriology, 7th edition, Tata- McGraw Hill

Paper II

Group A: Environmental Microbiology and Biophysical Chemistry (50 marks)

UNIT- I

1. **Air Microbiology(5)**

   Different types of microorganisms in the air, Bioaerosols, Factors affecting survival and growth of microorganisms in air. Aeromicrobiology of hospitals, laboratories and homes; Impact of aeromicrobiological content upon public health- role of air pollution, airborne pathogens, techniques of room sterilization.Air sampling techniques- impaction, liquid impingement, filtration, gravity sampling

2. **Soil Microbiology (12)**

   Soil as a habitat for microorganisms; Physico-chemical properties of different soil types; soil microbes, factors affecting microbial community in soil, Soil food web

   Basis of plant-microbe interaction in soil; Epiphytes and endophytes; Rhizosphere and rhizoplane microorganisms; factors affecting growth of microorganisms in the rhizosphere; Role of rhizosphere microbial community in soil fertility as decomposers; Brief idea about plant growth promoting rhizobacteria (PGPR),

   Brief account of microbial interactions in soil- symbiosis, neutralism, commensalism and co-metabolism, competition, amensalism, synergism, syntrophism, mutualism parasitism and predation; Mycorrhiza (VAM) and plant interaction

   Biological nitrogen fixation- symbiotic and non-symbiotic; Biochemistry of nitrogen fixation; Plant-microbe interaction in soil for symbiotic nitrogen fixation- cross inoculation group, leghemoglobin and root nodule; role of *sym* plasmid, *nif* genes and nod factors in nitrogen fixation

   Compost and biofertilizers- their advantages over chemical fertilizers; General production process of compost and microbial biofertilizres with examples, role of nitrogen fixing and phosphate solubilizing microorganisms in biofertilizers; Mycorrhizalbiofertilizers

   Biological pest control and its advantages; Brief idea about bacterial, viral and fungal insecticides with examples; Integrated Pest Management

   Brief description about some microbial diseases of agriculturally important plants- blast and brown spot of rice, black stem rust of wheat, stem rot of jute, red rot of sugarcane, late blight of potato, grey blight of tea

3. **Biogeochemical cycles (8)**

   Definition and ecological importance of biogeochemical cycles

   Carbon, nitrogen, phosphorus and sulfur cycles- role of microorganisms in the process

Suggested textbooks:

- Atlas, RM., Principles of Microbiology, 2nd edition, McGraw Hill
- Willey, JM., Sherwood, LM., Woolverton, CJ., Prescott's Microbiology, 9th edition, McGraw Hill
- Madigan, MT., et al., Brock Biology of Microorganisms, 13th edition, Benjamin Cummings
- Black, JG., Microbiology-Principles and explorations, 7th edition, John Willey & Sons, Inc.
- Talaro, KP., Talaro, A., Foundations in Microbiology, 4th edition, McGraw Hill
- Tortora, GJ., Funke, BR., Case, CL., Microbiology- an introduction, 10th edition, Benjamin Cummings
- Salle, AJ., Fundamental Principles of Bacteriology, 7th edition, Tata- McGraw Hill

UNIT-II

1. Fundamentals of thermodynamics and Bioenergetics(7)

Concept of thermodynamic system and surrounding, types of thermodynamic systems, extensive and intensive variables, State functions and path functions, Zero-th law, 1st law & 2nd law of thermodynamics: concept of internal energy, enthalpy and entropy; isothermal and adiabatic processes, reversible and irreversible work done, application in biological systems as typical example of isothermal, isobaric and isochoric process, Deduction of the concept of free energy from the second law, standard free energy change and its use as an indicator of spontaneity of reactions. Equilibrium constant; Concept of "High Energy bond" High energy compounds, Coupled reactions, Concept of chemical potential and its significance as chief determinant of free energy change in biological processes, gradient of chemical potential as driving force in transport, Donnan equilibrium, Nernst potential.

Transport across biomembranes: Fick's laws of Diffusion, passive diffusion, facilitated diffusion & active transport - (definition and examples of primary and secondary active transport); uniport, symport, and antiport; osmosis and osmotic pressure.

Forces in biological systems: Concept of strong bonds/interactions (Covalent bonds, co-ordinate covalent bonds, ionic bonds, hydrogen bonds, hydrophobic interaction), Charge-dipole interactions and weak forces (induced dipole and Van der Waal'sinteraction-London's dispersion forces, 6-12 potential) and their significance in biological interactions.

2. Fundamentals of Spectroscopy (7)

Concept of electromagnetic radiations - UV, visible, IR.

Preliminary ideas of Molecular Orbital theory- Linear Combination of Atomic Orbital (LCAO), Bonding and antibonding orbitals, Interaction of electromagnetic radiation with matter-Jablonski diagram, Franck-Condon Principle; Scattering Spectroscopy- Preliminary ideas about Rayleigh and Raman scattering, applications and drawbacks; Absorption spectroscopy-Concept of chromophore - Wit's chromophore theory, auxochorome. Quantum

mechanically allowed and forbidden electronic transitions (HOMO to LUMO) Hyperchromic, hypochromic, hypsochromic and bathochromic shifts-effect of conjugation and solvent polarity, Lambert-Beer's law- applications and reasons accounting for deviation, molar extinction co-efficient;

Infrared spectroscopy: Origin of IR spectra, relation of vibrational frequency with force constant ad reduced mass, different types of molecular vibrations, concept of fingerprint region of an IR spectra, limitations of IR spectroscopy.

Fluorescence spectroscopy: Explanation of red shift in emission spectra from Jablonski diagram, competing processes of fluorescence, internal conversion and intersystem crossing, idea of singlet and triplet state, concept of phosphorescence, fluorescence lifetime and quantum yield, quenching phenomena-static and dynamic quenching, examples of typical quenchers, biologically relevant applications of fluorescence, fluorescence energy transfer.

Instrumentation: Schematic diagram & working principle of UV-VIS and IR spectrophotometer,fluorimeter and their accessories including cuvettes.

Nuclear Magnetic Resonance Spectroscopy- Preliminary concepts, NMR active nuclei, Chemical shift, TMS as reference compound, Scalar and Dipolar interactions NuclearOverhauserEffect, applications in biology. NMR of simple molecules such as HCHO and CH_3OH.

3. Physical and chemical properties of water (4)

Ionic product of water; pH - definition, effect of pH in enzyme catalyzed reaction. Acids, bases; Arrhenius, Bronsted-Lowry theories of acid and bases. Polyprotic acids, ampholytes, dissociation of polyprotic acid; titrable and true acidity. Buffers in biological systems-Concept of weak acid,HendersonHasselbalch equation, buffer capacity, Amino acids as buffers, Formol titration and titration profile of amino acids (acidic, basic and neutral, one each), determination of isoelectric pH from titration profile. Physical properties of water-Surface tension, intrinsic and specific viscosity: Measurement, factors affecting and application to biomolecules.

4. Microscopy (7)

General principles of optics in relation to microscopy; different components of light wave (UV, IR, visible); principles and applications of Compound Microscope; Resolving power; Numerical aperture: Chromatic Aberration. Light Microscope; Dark field Mircroscope; Bright field Microscope; Phase Contrast Microscope; Fluorescent Microscope; Confocal Microscope, Electron Microscope;

Paper-II
Group B: Practical (50 Marks)

UNIT I

1. Microbiology: Good Laboratory Practices and Biosafety.

2. To study the principle and applications of important instruments (laminar air-flow, autoclave, incubator, hot air oven, light microscope, pH meter, BOD incubator, spectrophotometer) used in the Microbiology laboratory.

3. Preparation of culture media: Complex media (Nutrient Broth, NA slant, Lactose broth); Chemically defined, Syntheticmedia (Czapekdox broth / agar). YEPD / select media which will be used for the experiments specified.

4. Cultivation of Microorganisms: Streak culture on agar-slant/agar-plate : Bacteria (*Bacillus subtilis, Staphylococcus aureus, Escherichia coli*); Yeast (*Saccharomycescerivisiae*) Moulds (*Penicillium notatum, Aspergillus niger*). Pure-culture Isolation by streak-plate/pour plate methods.Inoculation of bacteria in nutrient agar slant.

5. Staining techniques for examination of microorganisms: i) Bacteria - preparation of heat-fixed smear and Simple straining (*E. coli, Bacillus subtilis, Staphylococcus aureus*) (b) Gram-staining of Gram positive (*B. subtilis, S. aureus, M.lutea*) and Gram-negative (*E. coli, K. aerogenes*) bacteria(c) Negative Stainng (d) Endospore staining (*B. subtilis*).
ii) Fungi- Lactophenol - Cotton blue staining of Yeast (*Saccharomyces cerevisiae*): Molds (*Penicillium notatum, Aspergillus niger*).

UNIT II

1. Qualitative tests of biomolecules (carbohydrates, proteins, amino acids, lipids):
Glucose, fructose (Benedict's Test, Barfoeds' test); sucrose (Acid hydrolysis & Benedict's Test); starch; Proteins (Biuret method); lipids (Salkowski test, TLC with detection by Iodine vapor).

2.Separation of aminoacids(Lysine, glycine, tryptophan, proline) by Thin Layer Chromatography.

3. Estimation of amino acid (Glycine) by formol titration.

4. Internal assessment

PART –II: 200 marks

Paper-III
Group A: Molecular and Cellular Biology (50 marks)

UNIT I

Replication, Transcription and Translation in Prokaryotes

Replication(5)

Semiconservative replication: Meselson-Stahl experiment. Bidirectional Replication: Structure of oriC, Proteins associated with Replication: DnaA, B, E,G, topoisomerses, ligases Mechanism of control of initiation: Iteron-based, small RNA based. Mechanism of termination: ter sites, Tus proteins. Partitioning of chromosome: *E.coli*ParA, ParB, parS system. Rolling-circle replication.Mitochondrial D-loop replication

Transcription (12)

Mechanisms of Initiation, elongation and termination, promoter structures(weak and strong promoters and consensus sequences).Bacterial RNA polymerases (*E.coli*) functions and domains.Mechanism of termination:rho-dependent and rho- independent terminationAntitermination: lambda N protein as example. Attenuation: novel control of gene expression in prokaryotes. Operons; Lac operon: structural genes, positive and negative controls, classical Lac mutants, complementation tests with lac mutants. Trp Operon: example of repressible operon. Ara Operon: example of positive regulation

Translation (8)

Description of ribosomal cycle.Phenomena of initiation, elongation, termination. Factors involved in initiation, elongation, termination. Genetic code.tRNA: clover-leaf structure and functiontRNA mutants: different suppressor tRNAs, rRNA: structure and function. Role of aminoacyltRNA synthetases.Non-ribosomal peptide synthesis.Cyclic peptide antibiotics e.g. Gramicidin etc.

UNIT-II

Eukaryotic Cell Biology (15)

Eukaryotic Cell Membrane.Difference in membrane constituents between eukaryotesand prokaryotes.Elementary idea of intracellular organelles.Transport across membrane - (Active, Passive, Facilitated). Comparison between eukaryotic and prokaryotic flagella and cilia;Cytoskeletal elements of eukaryotic cells.

Mechanism of action and antimicrobial spectrum of and cephalosporin group of antibiotics, Mechanism of drug resistance with example, selective toxicity of antibiotics, therapeutic index, MIC and MLC- concept and determination, Antibiotic sensitivity test, Fitness cost of antibiotics, subclinical application of antibiotics and its implications.

Cell Biology of Yeast: Budding and fission yeasts.Cell cycle.Secretory pathway in yeasts, preliminary ideas about Sec mutants, 3 types of esecretionand secretory metabolites.Transport of materials to the bud.
Protein degradation: prokaryotic and eukaryotic, elementary concepts of GroEL, GroES system, elementary concepts of proteasomal system, Chaperones and chaperonins.

Mycology (10)
General Characteristics and Classification of Fungi upto class with diagnostic features.
Fungal Morphology-Hyphaland mycelia types, types of asexual reproductive structures and spores. Sexual reproduction-mechanisms involved in fusion of gametes and types of resultant fruit bodies, parasexuality in fungi.
Yeasts - fission and budding yeasts,haplo and diplobiontic life cycles, mating types and switching of mating pairs, sec mutants and protein secretion in yeast .
Molds- difference with yeasts, life cycles of common molds -Rhizopus and Penicillium
Common fungal pathogens of human body, fungal diseases of common crops- paddy (brown spot),wheat (rust) ,potato(late blight)-symptom, causal organism, dissemination and control measures
Beneficial role of fungi – antibiotic producers, mycorrhizain agriculture, biofuel production, food production -mushroom,bakery, beverage and cheese, detritous fungi.

Suggested textbooks:

- Biochemistry—D. Voet and JG Voet,
- Snyder et.al.-Mol.Gen.of Bacteria
- Frifelder D
- Lewin et al. GENES
- Alberts B
- Lodish, H., et al. Molecular Cell Biology
- Prescott’s Microbiology: Joanne M Willeyet al
- Microbial Physiology: A.G. Moat
- Bacterial metabolism: Gerhard Gottschalk

Group B: Metabolism and Bioenergetics (50 marks)

UNIT I

Enzymes and Amino Acid Metabolism
Enzymes(15)
General properties, Nomenclature and Classification; Enzyme units, Co-factors : Definition and function with special reference to the representative substances - a) Co-enzymes (NAD+, NADP+, Co-enzyme-A, TPP, Pyridoxal phosphate, Biotin, Lipoic acid, tetrahydrofolate); b) Prosthetic groups (FAD+ - Succinic dehydrogenase); c) Metal ions Zn+2 Mg2+, Fe2+, Fe3+,

Mn2+ - required for enzyme action, Enzyme Kinetics –Thermodynamics of Enzyme kinetics, Michaelis-Menten equation and derivation Graphical presentation; L-B plot, Factors affecting Enzyme activity, Enzyme Inhibition - Competitive-cite: Malonate on succinate dehydrogenase as example, Non-competitive – Cite: lodoacetamide on triose phosphate dehydrogenase and EDTA as example; Irreversible inhibition-eg. Di-isopropyl fluorophosphate, Suicide inactivation-action of Penicillin on bacterial cell wall biosynthesis as an example; Regulatory enzymes-Allosteric – Cite: CTP on Aspartate transcarbamoylase as example; Feedback inhibition - Cite: Threonine to Isoleucine as example; Ribozyme (catalytic RNA) and Abzyme (use of antibody as enzyme) - Definition and example.

2. Amino acid metabolism (10): Catabolism: Transamination, deamination, transmethylation and decarboxylation. Glucogenic and ketogenic amino acids, Outline of Urea Cycle; Microbial metabolism of glycine, phenylalanine and lysine.Inborn errors of Metabolism.

Unit II

Carbohydrate Metabolism, Nucleic Acid Metabolism and Fat Metabolism

1. Carbohydrate metabolism (12)

Aerobic respiration-Glycolysis (EMP-pathway) with energy production: entry of galactose & fructose in EMP-path; TCA-cycle with energy production: Glyoxylate cycle: Pentose-phosphate pathway: Glycogenesis and Glycogenolysis, Electron Transport Chain (in brief) & ATP generation sites; Gluconeogenesis, Cori cycle, ATP & ADP cycle (oxidation reduction potential and electromotive force). Photophosphorylation, Oxidative phosphorylation (Chemiosmotic theory); Anaerobic respiration - Utilizing NO_3^- Sulfur SO_4^{-2} ,CO_2 as electron acceptors; Stickland-reaction; Entner-Doudoroff pathway, Fermentation - Glucose metabolism in anaerobic condition general concept only Bacterial photosynthesis (Cyanobacteria and Green-sulphur bacteria); Difference with eukaryotic photosynthesis.

2.Purine and Pyrimidine metabolism (5)

Synthesis of purines: elementary concept only, source of the precursors of purines, ribose 5phosphate; synthesis of AMP and GMP from IMP-only preliminary idea; Importance of folic acid and target of sulfonamides; Microbial reduction of purines to deoxy-purines: Role of Thioredoxine; Salvage pathways ,Biosynthesis of pyrimidines: Aspartate transcarbamoylase (ATCase); Origin of Thymine: importance of folic acid (conceptual); Degradation of nucleotides: xanthines, uric acid; catabolites of pyrimidines: NAD+ and Coenzyme A (only elementary ideas). Use of Fluorouracil, Trimethoprim, Methotrexate as chemotherapeutic agent by blocking the synthesis of Thymidylate.

3.Lipid metabolism(8)

Importance of fat, Types of Fatty acids, Detailed account for oxidation of even-andodd-carbon numbered, saturated and unsaturated fatty acids; Role of Carnitine in oxidation of

fatty acids,and βoxidation, formation of ketone bodies, Brief idea of fatty acid biosynthesis; Metabolism of Triglycerides and phospholipids

Suggested textbooks:

- Biochemistry—D. Voet and JG Voet,
- Biochemistry—L. Stryer,
- Biochemistry—Lehninger,
- Principles of Enzymology— T.Palmer.

Paper IV
Group A:Food, Water and Industrial Microbiology(50 marks)

UNIT I

1. **Food Microbiology (7)**

   Food as a substrate for microorganisms- pH, Moisture requirement (water activity), Oxidation-reduction potential, Nutrient content, Vitamins, microbial growth inhibitory substances in foods

   Contamination of foods- from plants, animals, sewage water, soil and air

   Food spoilage and its causes, classification of foods on the basis of ease of spoilage, factors affecting microbial spoilage of foods

   General principles of food preservation; Preservation by use of high temperatures (canning, Pasteurization), low temperatures, drying, food additives (salts, sugars, acids, spices, preservatives, antibiotics) and radiation; benefits and drawbacks of food preservation techniques

   Contamination, preservation and spoilage of cereals, vegetables and fruits, meats and meat products (TA spoilage, sulfur stinker spoilage etc.), fish and other sea foods, eggs and poultry, milk and milk products (stormy fermentation, ropy milk, coloured milk)

   Food-borne poisonings, infections and intoxications -bacterial and viral food borne diseases, mycotoxins, sea food toxicants, poisoning by chemicals

   Fermented milk and other food products- yoghurt, curd, acidophilous milk, butter milk, cheese, butter, bread, wine, malt beverages, vinegar, idli, dhokla; spoilage and defects of fermented dairy products

   General methods for assessment of microbiological contamination of cooked, preserved and fermented dairy and other food products; concept of food safety and good manufacturing practices; Hazard Analysis and Critical Control Points (HACCP)

2. **Water Microbiology (7)**

   Water as a habitat for microbial growth; different types of microorganisms found in water; factors affecting microbial growth in water; marine microbiology and fresh water microbiology

Microbial analysis of water – BOD and COD (basic concept and methods of determination and implication), Coliform test (detection of fecal and non-fecal coliform), Defined substrate tests (ONPG and MUG tests), IMViC tests, Determination of potability of water sample (MPN test)

Indicator organism, Eutrophication, algal bloom and red tide (their implications in public health)

Water treatment- sewage, industrial and drinking water and its importance in public health; Primary sewage treatment and secondary sewage treatment (activated sludge, trickling filter, rotating biological contactor, anaerobic sludge digesters, septic tank, oxidation ponds), tertiary sewage treatment

3. Industrial Microbiology (11)

Microbial culture selection by screening method with reference to the antibiotic and enzyme production (Primary and secondary screening techniques), Strain improvement – importance and procedure (in brief), Ideal features of an industrially important microorganism, Concept of Primary and secondary metabolites

Equipments and instrumentation, Fermenters (General description of different types- stirred tank, bubble column, air-lift, packed-bed bioreactor, photobioreactor), General strategy of fermenter designing, maintenance of aseptic condition in bioreactors, scale up of fermentation, ideal features of a bioreactor

Fermentation- static, submerged, agitated, solid phase, batch, feed-batch, continuous (general process, merits, demerits and comparison)

Preservation and maintenance techniques for industrially important microorganisms (general process, merits, demerits and comparison)

Immobilization of cells and enzymes- definition, general characteristics, general description of different processes (Ca-alginate beads, polyacrylamide, micro-film), their importance in industrial microbiology, merits and demerits

Industrial production of – ethyl alcohol, acetic acid, penicillin, Vitamin B_{12}, Lysine, α-amylase (inoculum building, fermentation, separation, assay and purification of products and factors affecting production- general discussion)

Suggested Textbooks:

- Salle, AJ., Fundamental Principles of Bacteriology, 7th edition, Tata- McGraw Hill
- Ray, B., Fundamental Food Microbiology, 3rd edition, CRC Press
- Frazier, WC., Westhoff, DC., Food Microbiology, 5th edition, McGraw Hill
- Dubey, RC.,Maheswari, DK., A Textbook of Microbiology, 2nd edition, S. Chand & Co. Ltd.
- Atlas, RM., Principles of Microbiology, 2nd edition, McGraw Hill
- Willey, JM., Sherwood, LM., Woolverton, CJ., Prescott's Microbiology, 9th edition, McGraw Hill

- Black, JG., Microbiology-Principles and explorations, 7th edition, John Willey & Sons, Inc.
- Talaro, KP., Talaro, A., Foundations in Microbiology, 4th edition, McGraw Hill
- Tortora, GJ., Funke, BR., Case, CL., Microbiology- an introduction, 10th edition, Benjamin Cummings
- Patel, AH., Industrial Microbiology, 2nd edition, Macmillan
- Casida, LEJR., Industrial Microbiology
- Presscott& Dunn, Industrial Microbiology
- Okafor, N., Modern Industrial Microbiology & Biotechnology, Science Publishers

Unit II

Biometry and Instrumentation

1. Biometry (5)

Introduction**:** Types of Biological Data (variables), Concept of Population and Sample.

Descriptions of Samples and Populations**:** Frequency Distributions, Descriptive statistics (measures of Central tendency and measures of Dispersion, Boxplot)

Probability**:** Introductory concepts, Conditional Probability: Independent and Dependent events, Mutually exclusive events.

Distribution Theory**:** Binomial, Normal and Poisson distribution**.**

Inferential statistics**:** Statistical estimation-concept of z and t statistic, difference in their scope of application, Statistical decisions-tests of hypotheses and significance or decision rules, p value, confidence interval, type I and type II errors, *z*-test. *t*test (paired and unpaired), one-tailed and two-tailed test. Brief discussions on the comparison of two independent population means. The Parametric and non-parametric models of significance tests (definition only), different Chi-square tests-Goodness of fit, Contingency or Independence of attributes,

Linear Regression and Correlation-Least square regression line, correlation co-efficient.

2. Instrumentation/Techniques for Characterization of Biomolecules (12)

Sedimentation and ultracentrifugation, Sucrose and Cscl based Density Gradient Equilibrium Centrifugation and its application; Electrophoresis, DNA and protein gel electrophoresis, Native and SDS PAGE, Isoelectric focusing, 2D Electrophoresis, Pulsed field Gel Electrophoresis; Chromatography-General principles of separation, types and scope of application of each- Thin Layer Chromatography,Gel-filtration chromatography, Ion-exchange chromatography, affinity chromatography, gas chromatography, FPLC, HPLC and UPLC.

3. Fundamentals of radioactivity (8)

Law of Radioactivity, Decay constant, half life, average life. Properties of α, β, γ

radiations, unit of radioactivity, radioactive carbon dating. Applications of radioactive isotopes (14C, 3H, 32P, $_{35}$S) in biological systems, (in Radioimmunoassay, tracer techniques with application in study of glucose metabolism, pulse-chase techniques with application in DNA replication as typical example). Principle of liquid scintillation counter.Radiation absorption- biological effectiveness- Linear energy transfer- radiation protection and safety aspects. ICRP rules on biosafety and biohazards.

Suggested text books:

- Tinoco, Sauer and Wang, Physical Chemistry, Principles and Applications in
- Biological Sciences, Prentice Hall, 4th Edition (2001).
- Zar, JH.,Biostatistical analysis, Pearson Education.
- Atkins, Physical Chemistry for the Life Sciences, W.H. Freeman (2005).
- Atkins, The Elements of Physical Chemistry, W.H. Freeman, 3rd Edition (2000)
- Cantor &Schimmel, Biophysical Chemistry, Part I, II, III, Freeman Press (1980-
- 1981).
- Eisenberg & Crothers, Physical Chemistry with Applications to the Life Sciences,
- Benjamin/Cummings Publishing Co. (1979).
- K. E. van Holde, W. C. Johnson, and P.S. Ho, Principles of Physical
- Biochemistry (1998).
- P. Atkins and J Paula, Physical Chemistry for the Life Sciences (2006).
- C.R. Cantor and P.R.Schimmel, Biophysical Chemistry (1980), Part I: The
- Conformation of Biological Macromolecules, Part II: Techniques for the Study of
- Biological Structure and Function.
- Forthofer, RN., Lee, ES. (1995) Introduction to Biostatistics: A guide to design,
- analysis and discovery, Academic Press.
- Schaum's outlines: Statistics by Spiegel & Stephens, Mcgraw Hill, second edition or higher.
- Biological Spectroscopy-Campbell and Dwek, Benjamin/Cummings.
- Introduction to Biostatistics, Dr. Pranab Kr. Banerjee, S. Chand.
- Biochemical calculations, Segel, 2nd Edition, Wiley.
- Principles of Molecular biology by Wilson and Walker.

Paper IV

Group B Practical (50 marks)

UNIT I

1.Micrometry:

Microscopic measurement of bacterial cell (*B.subtilis*), yeast (*Saccharomycescerevisiae*), fungal spores (*P. notatum, A. niger*).

Enumeration of microbes: Yeast by Haemocytometer (Standard Deviation Estimation)

Determination of viable cell count by Trypan Blue method.

2.Isolation of pure culture from natural sources:
Bacteria from soil-by serial dilution and pour-plate/spread plate method. (b) Yeastfrom rotten banana or apple by serial dilution and pour-plate/spread plate method (c) Molds from infected citrusfruits-by streak-plate method (d) Microbes from air, by agar-plate exposure method.

3. Growth curve of bacteria(*E. coli)* under normal condition and the effect of pH, temperature and salt on the growth curve.

4. Assay of antibiotics. Microbiological assay of antibiotics: Antibiotic sensitivity test by paper disc and by Cup-Plate method

5. Determination of Minimal Inhibitory Concentration (MIC) of antibiotic by serial dilution.

UNIT II

1. Water microbiology:

i) Microbiological examination of water (Drinking water, Supply water, Pond water) by
a) Presumptive test
b) Confirmatory test
c) Completed test
ii) IMViC reactions.

2. Milk microbiology
Microbiological examination of milk: By Methylene-blue dye reduction test.
Alkaline phosphatase test to check the efficiency of pasteurization of milk.

3. Study of the following protozoans using permanent mounts/photographs:
*Amoeba, Entamoeba,Paramoecium*and *Plasmodium.*

4. Internal assessment

PART –III: 400 marks

Paper V

Group A: Microbial Genetics (50 marks)

UNIT I

1. Mendelian genetics (5)
Definition and scope of Genetics. Brief idea on Epigenesis, Inheritance of acquired characters, Traits, Genotype and Phenotype, alleles, dominance, recessiveness and co dominance, semi dominance and lethal. Concept of Mono + Dihybrid cross and Principle on Independentassortment.Non-MendelianInterctions

2. Organization of genome(8)
Experimental evidence for DNA as genetic material (Experiments of Griffith, Avery and MacLeod; Hershey and Chase); Experimental evidence for RNA as genetic material
Discovery of the double helix structure of DNA by Watson and Crick. Invention of PCR technique by Karry Mullis
Chromosome banding pattern (G, C, R, Q banding) and significance, Special types of chromosome (Polytene and lampbrush chromosome), Definition of Karyotype and Idiogram.
Nucleic Acid structure: DNA double helix: crystallographic proof, alternative forms of DNA, intercalating agents, secondary and tertiary structure of RNA.
Structure prokaryotics gene; genomic organization in prokaryotes (nucleoid, DNA supercoiling, topoisomerases)**,** Extrachromosomal inheritance: Plasmids (genes found, copy number, compatibility) . Episomes.
Structure of eucakryotic genes (description and experimental proofs), multigene family. Genome organization (ARS, centromere, telomere, chromatin structure), various forms of repetitive DNA (satellite, LINEs and SINEs), pseudogenes. Extrachromosomal inheritance (mitochondria and plastids)

3.Linkage(definition) and crossing over (5)
Concept of Linkage(definition) and crossing over (two factor and three factor crosses).Related Problems. Theory of Coupling and Repulsion

4. Genetic exchange(7)
Transformation, Conjugation, Hfr bacteria and chromosome mapping. Transduction generalized (P1) and specialized (lambda-phage).
Transposable elements: Bacterial and Eukaryotic Transposons.

UNIT II

1. Mutation and Repair (15)
Spontaenous(Spontaneous mutation Luria - Delbruck's Fluctuation Test) and inducedmutations, Mutagenic agents - Physical, Chemical and Biological (Phage-mu).

Different forms of mutations and how they arise: (tautomeric shift, base analog, alkylating agent, apurinic lesions, UV radiation andthymine dimers, replicational error); Ames test is used the assess the mutagenecity ofcompounds.
Variations in chromosome number and structure: Brief idea on Deficiencies, Duplication, Inversions, translocation and Position effects, Trisomy Polyploidy, Euploidy. Non disjunction and Aneuploidy.
Repair:reversal of UV damage in prokaryotes: photoreactivation, base excision andnucleotide excision repair, post replicational repair, mismatch repair, SOS repair, errorprone repair.

2. Recombination (10)
Homologous recombination (Holiday structure:RecBCD system); gene conversion; site specific recombination (lambda)

Suggested textbooks:

- Molecular Biology of the Gene (5th edition): By James D Watson et al
- Concept of Genetics (6th edition): By Klug and Cummings
- Genetics: Principles and Analysis (4th edition): By Hartl and Jones
- Genetics: Analysis and Principles: By Robert J Brooker
- Principles of Genetics : By Gardner, Snustad and Simmons
- Microbial genetics: By Freifelder

Group B:Recombinant DNA Technology and Bioinformatics(50 marks)

UNIT I

1. Recombinant DNA Technology (25)
Isolation & purification of nucleic acids & protein, RFLP, RAPD, Finger printing, Southern blotting, Dot blotting. Northern blotting. Western blotting - techniques.
Cloning: Cloning vectors (pBR. 322, pUC8I9. YACs), Bacteriophage lambda and M13 based vectors. Cosmids, BAC, Ti plasmid as transformation vector. Use of linkers and adaptors
Construction of DNA libraries (Basic ideas and outlines of methods)
PCR techniques: Basic principle and application Types of PCR- Inverse, Multiplex, Nested, Real time, RT, AP PCR.
Sequencing: Overview of Maxam Gilbert, Sanger's method of DNA Sequencing: traditional and automated sequencing.
Restriction and Modification enzymes
Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering, Restriction Mapping
Enzymes used in Recombinant DNA techniques: DNA ligase. Polynucleotide Kinase. DNA Polymerase, Calf Intestinal Alkaline phosphatase, Mung Bean Nuclease, S1 Nuclease, Terminal deoxynucleotidetransferases, Reverse Transcriptase.
Over Expression of Recombinant Proteins in Bacteria:

Expression vectors: E.coli lac and T7 promoter-based vectors, Insulin, Human Growth Hormone, Recombinant vaccines

Gene Therapy
Definition and outlines of ex vivo and in vivo gene therapy.

Suggested Text Books:

- Brown TA. (2010). Gene Cloning and DNA Analysis.6th edition.Blackwell Publishing, Oxford, U.K.
- Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition.Blackwell Publishing, Oxford, U.K.
- Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
- Richard J Reece (2004) Analysis of Genes and Genomes. John Wiley & Sons, Ltd.
- Lodge J, Lund P & Minchin S (2007) Gene Cloning: Principles and Applications Taylor and Francis Group
- Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication.

Unit II
Genomics, Proteomics and Bioinformatics (25)

Basic concepts of Genome, transcriptome, Proteome, Genome Projects-Objectives; Genome organization and diversity
Bioinformatics: Introduction, Objectives and Applications. Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot. Basic Concept of Sequence Alignment (Demonstration wherever possible)

Suggested textbooks:

- Gene cloning and DNA analysis: T. A. Brown.
- Principles of Gene Manipulation and Genomics: S.B. Primrose and R.M. Twyman
- Molecular Biology: Weaver
- Introduction to Bioinformatics: Arthur, M. Lesk.
- Genomes 2: T.A. Brown
- Proteins: structure and molecular properties: Thomas E. Creighton

Paper VI

Group A: Medical Microbiology and Virology (50 marks)

UNIT I

Medical Microbiology (25)

Normal Microbial Flora of human body

Mutualism, Commensalism, Parasitism.Protective role of normal microbiota and their dynamic nature.Mechanism of Bacterial Pathogenicity: entry, colonization, pathogenicity Course of infectious disease, duration of symptoms
Mechanism of damage of host cell Exo-and endotoxins - definition and general properties Mechanism of action of toxins Neurotoxin-botulinum toxin, tetanus toxin Enterotoxin-Cholera toxin, Salmonella toxin, Klebsiella toxin Cytotoxin: Shigella toxin, Diphtheria toxin

Antimicrobics
General properties of synthetic and naturally occurring antimicrobial drugs: selective toxicity, spectrum of action, modes of action, side effects. Mechanisms of action of antibacterial agents: Inhibitors of 1) Cell wall synthesis 2) Membrane function 3) Protein synthesis 4) Nucleic acid synthesis 5) Inhibitors with other modes of action Antifungal, antiviral, antiprotozoan and antihelminthic agents. Drug resistance: mechanism of drug resistance, origin & transmission of drug resistance

Common Microbial Diseases
Causative agents, Signs and Symptoms, Pathogenesis, Treatment & Prevention, and Epidemiology of the following:
Bacterial Diseases: a) Tuberculosis b) Pneumonia c) Tetanus d) Cholera e) Gonorrhea
f) Urinary Tract Infection g) Typhoid. Viral Diseases: 1) Influenza 2) Dengue Fever 3) AIDS.Fungal Diseases: Candidiasis.Protozoan Diseases: 1) Malaria 2) Amoebiasis 3) Giardiasis [

UNIT II

1.Virology: (20)

General characteristics of viruses: Definition, Properties, Components,Classification, Replication, Cultivation and Assay, Pathogenesis.Classification of Bacteriophage: Lytic phages: Penetration, Reproduction and Phage growth, estimation of phage numbers (T4 phage as model) Lysogenic Phages: mechanism(s) that determines lytic and lysogenic life cycle, SOS response of the host (Lambda phage as model). Filamentous Phage: M13 as model. Retroviruses: structure, classification, life cycle; reverse transcription,HIV as an example. Other infectious agents: Viroids and Prions

2.Microbial community (5)
Concepts of microbial Populations, Guilds and Communities, Environments and Micro environments

Suggested textbooks

- Brock Biology of Microorganisms - Madigan, Martinko, Bender, Buckley, Stahl and Brock
- Microbiology: A Human Perspective- Nester, Anderson, Roberts
- Principles of Microbiology-R.M.Atlas
- Medical Microbiology-David Greenwood
- Prescott's Microbiology- Joanne Willey and Linda Sherwood
- Principles of Gene Manipulation and Genomic: Primrose and Twyman
- Gene Cloning and DNA Analysis: An Introduction - T. A. Brown
- Microbial Genetics-David Freifelder and Freifelder
- Medical Virology - David O.White and Frank J. Fenner

Group B: Immunology (50 marks)

UNIT I

Introduction: overview of the Immune system

1. Cells and organs of Immune system(8): Hematopoietic stem cells, stromal cells, hematopoietic growth factors, Lymphoid organs (primary and secondary) and cells, Mononuclear cells, Granulocytic cells, Mast cells, Dendritic cells- characteristics and functions.

2. Types of Immunity(12):(i) Innate immunity - mechanism of immune response (anatomic, physiological, phagocytic and inflammatory barriers).
(ii) Adaptive immunity: Humoral and Cell-mediated immunity - mechanism of immune response---antigen processing and presentation, types and structures of Major histocompatibility complex molecules (MHC) and their role in antigen presentation, clonal selection of lymphocytes, definition of cytokine, generation of humoral and cell mediated response by cellular interactions (general concept only).

3. Antigens(5): chemical nature, antigenicity, immunogenicity, hapten, epitopes, mitogens (definition, properties, examples); Adjuvant (definition, examples, function)

UNIT II

1. Immunoglobulins(5): Isotypes- definition, basic and fine structures, general characteristics and functions. Monoclonal and polyclonal antibody (definition and characteristics).

2. Antigen - Antibody interactions(5): Precipitation reactions-Radialimmunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutinationreactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition.

3. Complement (5): The complement components, function, complement activation-
(i) Classical, (ii) Alternate and (iii) lectin pathways (characteristics & functions).

4. Hypersensitivity(3): definition, types, examples.

5. Vaccines (7): Development of vaccination- contribution of Edward Jenner Louis Pasteur. Active and passive immunization (definition, characteristics,
examples and functions). Attenuated and inactivated viral or bacterial vaccines
(definition, characteristic, functions, examples).

Suggested textbooks

- Immunology—JenisKuby
- Basic Immunology—Abbas

Paper VII (Practical 100 marks)

UNIT I

1.Isolation and characterization (activity, specific activity, pH optima, thermal denaturation profile etc) of one industrially important enzyme (amylase) and immobilization of amylase producing cells.

2. Determination of Km, Vmax and pH optima, effect of activator, inhibitor of alkaline phosphatase.

3. Review Writing

UNIT II

1. Protein estimation by Lowry method.
2. Absorption spectra of DNA and protein, hyperchromic shift of DNA.
3. Separation of protein molecules by SDS gel electrophoresis.
4. Internal assessment

Paper VIII (Practical 100 marks)

UNIT I

1. Antigen-Antibody reaction:
   a) Agglutination (blood typing method)
   b) Ouchterlony's agar double diffusion method (Dilution study and study of patterns)
   c) Single radial immunodiffusion (Mancini's method),
   d) Immunoelectrophoresis.

2. Restriction digestion of lambda and plasmid DNA.
   Visualisation of the DNA fragments by Agarose gel electrophoresis.

UNIT II

1. Isolation of plasmid-DNA (*E.coli* - DH 5α) by standard miniprep method.
   Visualisation of the DNA fragments by Agarose gel electrophoresis.
Quantification of plasmid DNA and checking the purity.

2. Isolation of Genomic DNA andvisualisation of the DNA fragments by Agarose gel electrophoresis.

3. Transformation of *E. coli* using plasmid DNA by $CaCl_2$ method.

4. Internal assessment.