VIDYASAGAR UNIVERSITY

MICROBIOLOGY

(Honours)

Under Graduate Syllabus

(3 Tier Examination Pattern)

w.e.f. 2014-2015

REVISED

Vidyasagar University

Midnapore 721 102

West Bengal

MICROBIOLOGY

Honours (B.Sc.)

3yr Degree Course in 3-tier Examination pattern

Part-I		Marks
Paper 1	General Microbiology	65
	Microbial Cell Biology	25
Paper 2	Chemistry of Biomolecules	35
	Metabolism	35
	Biophysics	20
Part-II		
Paper 3	Agricultural Microbiology	25
	Environmental Microbiology	25
	Computer	20
	Basic Mathematics and Biostatistics	20
Paper 4	Immunology and clinical microbiology	45
	Food and industrial microbiology	45
Paper 5	Practical	100
Part-III		
Paper 6	Microbial Genetics	45
	Genetic Engineering	45
Paper 7	Practical	100
Paper 8	Practical	100

Paper - I
General Microbiology

Unit – 1: History and development of microbiology (10 classes)

Definition, scope and area of microbiology. Spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation. History and development in microbiology with special reference to the contribution of following scientists: Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Paul Ehrlich, Edward Jenner, Beijerinck, Winogradsky, Alexander Fleming. Development of medical, immunology, agricultural, food, industrial microbiology and environmental microbiology.

Unit – 2: Diversity of microbial world (30 classes)

Viruses:
Classification according to Baltimore. General characteristics including morphology. Special emphasis on bacteriophage, TMV, HIV. Concept of viroids, virusoids and prions.

Bacteria:
Classification according to Haeckel, Whittaker, Carl Woese. Major taxonomic group of bacteria as per Bergey's manual. Phylogenetic and molecular characteristics used in identification. Characteristics of spirochetes, Mycoplasma, Actinomycetes, Reickettsia, *Chlamydia.* General features of Eubacteria, Archaebacteria, proteobacteria and Cyanobacteria.

Fungi:
Classification according to Webster and modern approaches. General characteristics of different groups. Heterothallism and para-sexual mechanism. Life cycle of *Aspergillus, Rhizopus, Penicillium, Saccharomyces* and *Agaricus.*

Algae:
Classificauon according to Smith. General characteristics of different classes, economic importance. Life cycle of *Spirulina, Chlorella,* Diatom and *Laminaria.*

Protozoa:
Classification according to Levine et al. General characteristics. Life cycle of *Entamoeba, Giardia, Plasmodium.*

Unit – 3: Culture media **(10 classes)**

Types of media (synthetic, semi-synthetic, complex, selective, differential, enriched media). Specific media for bacteria (nutrient broth/agar, plate count agar, Muller Hington media), algae (Chu), fungi (Czapek Dox, Sabouraud Dextrose), virus (bacterial, plant and animal cultures). Preparation of media, sterilization, aseptic and pure culture technique (pour plate, spread plate and streak plate). Culture preservation methods.

Unit – 4: Microscopy **(8 classes)**

General principles of optics in relation to microscopy. Spectrum of light waves. Component and parts of compound microscope. Principles and applications of phase contrast, fluorescent and electron microscope (TEM and SEM). Idea about modern microscopy.

Unit-5: Staining technique **(5 classes)**

Classification of stains, simple and differential staining, negative staining. Chemistry of stains, dyes and mordants used in microbiological works. Principles and procedure of Gram, acid fast and endospore staining, capsule staining, flagella staining, fungal and algal staining.

Microbial Cell Biology

Unit-1: Cell physiology (16 classes)

Structure of prokaryotes and eukaryotes. The external and internal structure of bacteria like flagella, pili, capsule, sheath, cell wall, prosthecae, cytoplasmic membrane, cytoplasm, nuclear materials, protoplast, spheroplast, and cyst (composition and function). Cytoplasmic inclusions - *Chlorobiwn* vesicles, gas vacuoles, magnetosomes, carboxysomes. Reserve food materials (nitrogen and non-nitrogen types). Bacterial endospore- ultrastructure. Sporulation and germination. Fungal cell wall and spore: morphology and composition. Molecular basis of motility, chemotaxis, movement of cilia and flagella. Cell division: mitosis and meiosis.

Unit -2: Growth (10 classes)

Physiology of growth, nutritional requirements, factors affecting growth (pH, temperature, oxygen, osmotic pressure etc). Measurement of growth (Cell mass and cell number). Growth curve and kinetics. Diauxic growth, batch, fed-batch, continuous and Synchronous culture. Growth in anaerobic condition.

Unit-3: Control of microorganisms by physical and chemical agents (12 classes)

Definition- sterilization, disinfectant, antiseptic, sanitizer, germicide, bacterioicide, bacteriostatic, antimicrobial agent. Factors affecting antimicrobial agent activity. Physical methods - temperature, filtration, radiation, desiccation and osmotic pressure (process and mechanism of action). Chemical agents - phenolics, alcohols, halogens, heavy metals, quarternary ammonium compounds, aldehydes, sterilizing gases (procedure and mechanism of action). Evaluation of antimicrobial agent effectiveness; phenol coefficient.

Paper – II
Chemistry of Biomolecules

Unit-1: Organic Reactions Mechanism (8 classes)

Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Unit-2: Carbohydrates (6 classes)

Definition, classification, structural concept of monosaccharides, disaccharides, oligosaccharides, homo/heteropolysaccharides, amimo sugars. Properties: asymmetric carbon atom, mutarotation, optical isomerism.

Unit-3: Proteins (6 classes)

Definition, classification. Amino acids: structure and properties. Non-protein amino acids. Concept of peptide bond and polypeptide chain. Protein structure: primary, secondary, tertiary and quaternary. Reaction with Ninhydrin. Reactions of carboxyl and amino groups.

Unit-4: Lipids (6 classes)

Definition, nomenclature and classification of different types of lipid, cis-trans isomerism. Structure of mono-, di- and triglycerides (simple and mixed); Conjugated and derived lipids (phospholipids, glycolipids, sphingolipids, steroid compound, eicosanoid).

Unit -5: Nucleic acid (6 classes)

Classification of nucleic acids, concept of purine and pyrimidine bases, nucleosides and nucleotides. Chemical properties - effect of acid and alkali, viscosity, denaturation and renaturation, Statics value. Types of DNA [A-DNA, B-DNA and Z-DNA (structure and difference)] ; structure and types of RNA (tRNA, mRNA, rRNA).

Unit-6: Enzymes **(8 classes)**

Definition, nomenclature, classification. Concept of co-enzyme and co-factors. Specificity, enzyme activity, active site, enzyme-substrate complex (Lock & Key, Induced fit). Effect of temperature, pH and substrate concentration on enzyme activity. Enzyme kinetics: Michaelis – Menten equation, Lineweaver – Burk plot. Enzyme inhibition: competitive, non-competitive and uncompetitive. Allosteric modulation. Ribozyme, abzyme and isozymes.

Metabolism:

Unit -l: Carbohydrate metabolism **(10 classes)**

Glycolysis, TCA-cycle, pentose-phosphate-pathway, glycogenolysis, Gluconeogenesis, Entner Doudroff Pathway, Glyoxalate cycle. [Pathway, energitics, significance], Synthesis of bacterial cell wall. Bacterial photosynthesis.

Unit - 2: Protein metabolism **(6 classes)**

Amino acid: Transamination, deamination, transmethylation and decarboxylation. Urea cycle (pathway and significance). Metabolism of glycine and phenylalanine (pathway).

Unit-3: Lipid metabolism **(6 classes)**

Oxidation of saturated even number fatty acid (β oxidation). Fatty acid (C_{16}) biosynthesis. Ketogenesis. Formation of lipoproteins and their significance.

Unit – 4: Nucleic acid metabolism **(4 classes)**

Purine and pyrimidine biosynthesis (Salvage pathway). Catabolism of purine.

Unit-5: Bioenergetics **(6 classes)**

ATP-ADP cycle, energy charge (phosphate potential) and its retention to metabolic regulation. Substrate level phosphorylation. Electron-transport chain, oxidative phosphorylation (brief idea), uncouplers, inhibitors and ionophores.

Biophysics

Unit-I: Structure and bonding **(8 classes)**

Modern concept of atomic and molecular structure; covalent, ionic, hydrogen bonds; Vander-Walls force and hydrophobic interactions. Molecular orbital and valence bond approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridization, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy.

Unit-2: Thermodynamics and reaction kinetics **(4 classes)**

First, second and third law of Thermodynamics, closed and open system, entropy, enthalpy, Gibbs free energy. Reversible and irreversible processes. Exergonic and endergonic reactions. Order of reactions and rate constant. Activation energy.

Unit-3: Biophysical phenomena and solvent system **(6 classes)**

Basic idea and significance or important physical phenomena like surface tension, surfactant, viscosity, diffusion, osmosis, adsorption, absorption, colloid, Gibb-Donnan membrane equilibrium. Physico – chemical Properties of water, Ionic product of water; pH- definition, Acids, bases and buffers in biological system; Polyprotic acids, ampholytes, amphipathic substance, polar and non-polar compounds.

Unit-4: Radioactivity **(5 classes)**

Radioactive and non-radioactive (heavy) isotopes, laws of radioactivity, half life and average life, types of radiations (alpha, beta and gamma radiations). unit of radioactivity.

Applications of radioactive and heavy isotopes in biology. Hazards or radioactivity in living systems.

Unit-5: Instrumentation **(10 classes)**

Principle and use of autoclave, incubator, hot air oven, laminar air flow system, centrifuge, spectrophotometer, colorimeter, deep freezer, lyophilizer, sonicator, rotary evaporator, electrophoresis, chromatography, thin layer chromatography, gel-filtration, paper chromatography, ion-exchange chromatography.

Paper – III
Agricultural Microbiology

Unit-1: Microbial interaction **(2 classes)**

Brief account of microbial interaction - symbiosis, neutralism, mutualism, commensalism, competition, amensalism, synergism, parasitism, predation.

Unit - 2: Soil microbiology **(5 classes)**

Types, composition and characteristics of soil. Different microbial groups in soil, humus formation and decomposition, compost formation, soil nutrients, leaching of minerals (copper, uranium and gold), Microorganisms of rhizosphere, rhizoplane & phyllosphere and phylloplane (Isolation, enumeration and significance).

Unit-3: Microorganisms in agriculture **(8 classes)**

Biological nitrogen fixation - symbiotic, non-symbiotic and associative: nitrogenase enzyme system, O2-sensitivity of nitrogenase-alternative nitrogenase, leghemoglobin, biochemistry/mechanism of N_2 fixation, nif and nod genes (basic concept). Nodule formation in leguminous plant, Phosphate solubilizing microorganisms (PSMs), mycorrhizae: ecto, endo, ectendo. VAM.

Unit-4: Applied agricultural microbiology (5 classes)

Concept of biofertilizers: Types and mass production (Rhizobium, Phosphate solublizer, BGA & VAM). Application of Biofertilizers. Biopesticides and biogas (organisms, mode of application and importance).

Unit-5: Plant Pathology (5 classes)

Sign and symptoms of Pyricularia oryzae-rice blast disease; *Plasmopara viticola* -Downy mildew of grape; *Xanthomonas oryzae*- bacterial leaf blight of rice; *Helmintosporium oryzae* – brown spot of rice; *Phytophthora infestans* – late blight of potatoes; *Erwinia amylovora* – fire blight of pear and apple; *Mycoplasma* (Sandal spike, Grassy shoot),Tomato leaf curl viruses; Plant Parasitic Nematode (PPN); *Puccinia graminis tritici*- stem rust of wheat; and *Ustilago tritici* - loose smut of cereals. Control of pathogenesis (Quarantine).

Environmental Microbiology

Unit-1: Aeromicrobiology (5 classes)

Aerosol. Aeromicrobiological (AMB) pathway, Different types of microorganisms in the air. Effect of environmental factors. Brief account of air borne pathogens and preventive measures. Some important air borne microbial diseases.

Unit-2: Biogeochemical cycle (4 classes)

Major biogeochemical cycles and the organisms: carbon, nitrogen, phosphorous and sulphur.

Unit-3: Bioremediation (8 classes)

A brief idea about biodegradation of petroleum, hydrocarbons, heavy metals, xenobiotics, bioremediation, phytoremediation, rhizoremediation and bioaccumulation /

biomagnification, biodeterioration. Bioplastics and its importance. Biofilm formation and importance. Quorom sensing bacteria and mechanism.

Unit-4: Aquatic microbiology **(8 classes)**

Ecosystem – fresh water (ponds, lakes), marine (estuaries, mangroves, deep sea), Potability of water: microbial assessment of water quality (presumptive test/MPN test, confirmed test and completed test, membrane filter technique), Indicator organism, coliform - faecal and non-faecal coliform, IMViC test, water purification, Biological waste water treatment: Waste water characteristics, BOD, COD, Secondary treatment (Activated Sludge, Oxidation Pond, Trickling filter). Brief account of water borne diseases and preventive measures.

Computer

Unit 1: Fundamentals of computer **(10 classes)**

Introduction to computer, classification of computer; computer generation; low, medium and high level languages, Software and hardware, input and output-devices, operating systems, compilers and interpreters, BIT, BYTE, WORD, computer memory and its types, Data representation and storage, Binary codes, binary system and its relationship to Boolean operations: mini, main, frame and super computers.

Unit 2: Computer application **(20 classes)**

Microsoft office, graphs, aggregates function, formulas and functions. Fundamental ideas about internet operation. Bioinformatics :database types used for nucleic acid and protein sequence study.

Basic mathematics and Biostatistics

Unit 1: Fundamentals of mathematics **(10 classes)**

Basic calculus, limits, derivative and integration.

Unit 2: Biostatistics **(20 classes)**

Nature and scope of statistical methods and their limitations. Definition of population, parameter and sample. Distribution of samples, frequency distribution, mean, median, mode, variance, standard deviation and standard error of mean Normal probability distribution, skewness. kurtosis. Representation of samples, frequency polygon, histogram, bar diagram, pie diagram, normogram.

Paper – IV
Immunology and Clinical Microbiology

Unit- 1: Introduction to infection and immunity **(6 classes)**

History, mechanism of pathogenesis. Immunity-natural and acquired, active and passive. Defense mechanism -first, second and third line defense, inflammation.

Unit - 2: Immune component and related factors **(14 classes)**

Antigen: properties and type; Immunoglobulin: structure, classes and function. Complements: components and biological activity. Immunological cells and their receptors - B cell, T cell. Antigen presenting cells (APCs), Phagocytosis, Major Histocompatibility Complex (MHC), monoclonal antibody (production procedure and application).

Unit - 3: Immunological reaction **(10 classes)**

Humoral and cell mediated immune response, antigen-antibody interaction (primary and secondary). Concept of vaccine. Types of hypersensitivity reactions, Auto immune diseases (cause and effect).

Unit – 4: Epidemiology of infection diseases (12 classes)

Transmission of infections and host susceptibility. Types of diseases -epidemic, endemic, pandemic, sporadic, zoonoses and nosocomial infection. Bacterial toxin: Exotoxin and endotoxin. Diseases caused by certain specific pathogens (symptoms, pathogenesis and prevention) - *Staphylocovcus aureus, Streptococcus pneumoniae, Mycobacterium tuberculosis, Salmonella typhi, Vibrio cholerae,* Human Immunodeficiency Virus, Hepatitis virus., *Entamoeba histotytica, Plasmodium species*, dermatophytes.

Unit-5: Antibiotics (8 classes)

Definition and classification of antibiotics, basic mechanism of antibiotics, antimicrobial spectrum of antibiotics and mode of action of the following antibiotics: penicillins, polymyxin, bacitracin, streptomycin, chloramphenicol, tetracycline, cycloheximide, gresiofulvin, nystatin. Generation of antibiotics, standardisation of antibiotics. Antiviral and synthetic chemotherapeulic agents. Drug resistance. Drug-microbes - host interaction. Concept of antiprotozoan and antihelminths drugs.

Food and Industrial Microbiology

Unit 1: Food microbiology (7 classes)

Importance of microorganisms in food preparation- bacteria, yeast and molds (only name & function). Principles of food preservation -asepsis, removal of microorganisms, anaerobic condition, high and low temperature, pressure, canning, drying, chemical preservation, food additives, bacteriocin.

Unit 2: Food spoilage (10 classes)

Food spoilage and food borne infections of natural and prepared food. General principles of food spoilage and contamination. Spoilage of canned foods, vegetables, milk and meat products. Food poisoning: staphylococcal food poisoning, botulism, salmonellosis, mycotoxins.

Unit 3: Development of industrial microbiology (12 classes)

History and development, general concept of industrial microbiology, principles of exploitation of microorganisms and their products screening, strain development. Fermenter: Types of fermenter, operation characteristics of fermenters, culture media, sterilization, inoculum preparation, aeration, agitation, foam control, Scale up process, downstream processing.

Unit 4: Fermentation processes (7 classes)

Types of fermentation — surface, submerged, solid state, single, batch, continuous, dual or multiple fermentation.

Unit 5: Microbial biotechnology (14 classes)

Food fermentations and food produced by microbes. Fermented foods: classification and nutritional value. Production of bread, cheese, vinegar, fermented dairy products: Yoghurt, fermented vegetables: sauerkraut, Single Cell Protein (SCP), Single Cell Oil (SCO). Mushroom, alcohol, amylase, Penicillins, riboflavin and glutamic acid. Biofuel (including algal origin). Probiotics and its application.

Paper – V
Practical

Basic Microbiology

Group A: (10 marks)

Basic rules of a microbiology laboratory for safety and good laboratory practice.
Simple and differential staining: Gram staining, capsule staining, endospore staining, fungal staining, acid fast staining, negative staining.
Observation of motility in bacteria by Hanging drop method.
Counting of bacteria and yeast by hemocytometer.

Group B: (20 marks)

Preparation of culture media (solid/liquid) for bacteria and fungus/algae.
Preparation of slant and stab culture.
Enumeration of bacterial number from soil and water by serial dilution and plating (spread plate and pour plate) method.
Isolation of single colonies of bacteria and fungi on solid medium by streak plate method.

Group C: (10 marks)

Characterization of bacteria through sugar fermentation, catalase, oxidase, starch hydrolysis, gelatin hydrolysis, urease test, H_2S production and nitrate reduction test.
Characterization of mycelium and spore of the fungi.

Identification of slides: Fungi *(Aspergillus, Penicillium*, yeast), Protozoa *(Entamoeba, Plasmodium, Trypanosoma)*, Algae *(Chlorella, Sprumlina, Laminaria),* Helminths *(Ascaris)*.

Biochemistry

Group A : Qualitative analysis (10 marks)

Identification of biomolecules by systematic analysis - Carbohydrate: starch, dextrin, disaccharide & monosaccharides (glucose & fructose).

Identification of biomolecules by systematic analysis - Protein: Peptone, Gelatin, Albumin

Identification of biomolecules by systematic analysis - Fat: Glycerol, Cholesterol

Identification of amino acids through thin layer chromatography technique

Preparation of buffer of different strength and adjustment of pH

Group B : Biochemical estimation (10 marks)

Estimation of DNA by DPA method

Estimation of RNA by Orcinol method

Estimation of Protein by Lowry method

Estimation of glucose by Nelson-Somogyi method

Estimation of cholesterol by $FeCl_3$ method

Estimation of Bilirubin by Diazo method

Estimation of acid number of fat

Group C : Enzyme Assay (10 marks)

Determination of activity of amylase/protease: Effect of pH, temperature and substrate concentration on enzyme activity.

Group D : Statistical Analysis (10 marks)

Computation of frequency distribution, drawing of histogram and frequency polygon, mean, median, mode, standard deviation and standard error from the data obtained from any microbial experiment. Calculation of these statistical indices using Microsoft Excel or other software.

Viva (10 marks)

Lab Note Book (10 marks)

Paper –VI
Microbial Genetics

Unit - 1: Mendelian Genetics (5 classes)

Genotype and phenotype. Outline of Mendelian genetics - monohybrid crosses: the principles of dominance and segregation; dihybrid crosses: the principles of independent assortment, back cross, incomplete and co-dominance, epistasis.

Unit – 2 : Genetic materials (15 classes)

Concept of gene, cistron, recon, muton. Prokaryotic genome: nucleoids, viral genome. Eukaryotic Chromosome : composition, nucleosome structure – solenoid model. Polytene and Lampbrush chromosome, euchromatin, heterochromatin, centromere, telomere, SINEs, LINEs. Bacterial plasmid: structure and properties. Transposition: type, structure and function of bacterial transposons. Mitochondrial DNA. Recombination (homologous and non-homologous).

Unit - 3: Flow of hereditary characters (10 classes)

Concept of central dogma. Out lines of replication of prokaryotic DNA - semiconservative, rolling circle and theta (θ) mode replication. Enzymes involved in replication, replication process in prokaryotes. Transcription of RNA. Translation. Genetic code, Wobble hypothesis.

Unit- 4: Regulation of gene expression (5 classes)

Concept of operon: induction and repression. lac & tryptophan operon system in bacteria, catabolite repression, attenuation; lytic and lysogenic cycle of phage (T_4 & λ).

Unit-5: Gene transfer (5 classes)

Nature, process and significance of bacterial gene transfer through transformation, conjugation and transduction. Interrupted mating experiment.

Unit-6: Mutation **(5 classes)**

Spontaneous and induced mutation, types of mutation; base pair changes (transition, transversion) frameshifts, insertions, deletion, inversions, tandem duplication. Major physical and chemical mutagens and their mode of action. Isolation of microbial mutant (auxotrophic, conditional lethal, resistant). Mutational hot spot. Site directed mutagenesis. Luria - Delbruck's Fluctuation Test, Ames test.

Unit - 7: DNA repair **(5 classes)**

Type of repair systems like mismatch, base-excision, nucleotide excision, photoreactivation, SOS repair, recombination repair.

Genetic Engineering:

Unit -1: Enzymes used in genetic engineering **(10 classes)**

Restriction endonuclease – types, nomenclature, properties and uses. Restriction modification system. DNA modifying enzymes and their applications: exonuclease III, S1 nuclease, DNA ligase (T4 and *E.coli*), alkaline phosphatase, reverse transcriptase, DNA polymerase, T4 polynucleotide kinase, terminal transferase.

Unit -2: Vectors **(8 classes)**

Cloning and expression vectors – definition, Classification and properties. Plasmid vectors – pBR322 and pUC series, phage vector, cosmid, phagemid, M13, BAC and YAC. Shuttle vectors. Ti plasmid as transformation vector.

Unit- 3: Tools used in genetic engineering **(8 classes)**

Blotting techniques: Southern, northern and western blotting (principle & technique). Colony hybridization technique, Dot blot technique, PCR (principle & uses), DNA sequencing (Sanger method). Protein sequencing (Sanger method).

Unit-4: Cloning **(10 classes)**

Steps in gene cloning, insertion of a foreign DNA fragment into a vector, concept of linker and adapter. Transfer of recombinant DNA into host cells, selection (screening) of recombinant DNA, blue-white selection method. DNA library- genomic and cDNA libraries, DNA fingerprinting, RFLP, RAPD, chromosome walking, DNA microarray.

Unit-5: Application of genetic engineering **(12 classes)**

Methods for preparation of transgenic plants and animals (basic concept). Methods of gene transfer: *Agrobacterium* mediated gene transfer; direct gene transfer: electroporation, microinjection, lipofection, gene gun. Application of genetic engineering (outline) - nif genes, insulin, antirabies vaccine, human growth factor. Application of genetic engineering in agriculture, medicine and environmental pollution control. Biohazards and bioethics of genetic engineering.

Paper –VII
Practical

Group – A : Haematological tests (20 marks)

Blood cell staining (by Leishman stain).
Differential count of WBC.
Total count of RBC& WBC.
Determination of Hb, ESR.
Agglutination test -blood grouping (ABO & Rh) and Widal test.
Observation and identification of malarial and filarial parasites from blood film.

Group – B : Pathophysiology (20 marks)

Study of nasal and throat surface culture.
Bacteriological analysis of urine.
Examination of stool - protozoa, ova and cyst.
Testing for antibiotics/drug sensitivity/resistance.
Determination of MIC value for antimicrobial chemicals.
Preparation of selective culture media for growing pathogenic bacteria (*E. coli, Staphylococcus aureus*)

Group – C : Food Microbiology (20 marks)

Microbial examination of fresh/spoiled food and fruits.
Microbial (aerobic and anaerobic) examination of milk and milk products.
Phosphatase (reductase II) activity of milk.
Isolation of Lactobacillus from milk products.
Enzymatic test of milk by methylene blue reductase test.

Group – D : Group Project (20 marks)

(Work-5; writing skill-5; group discussion-10 each group consists of maximum 5 students. The results/data obtained from the project work should be represented by graph/chart using Microsoft word and excel)

Viva (10 marks)
Lab Note Book (10 marks)

Paper – VIII
Practical

Group – A : Agricultural Microbiology: (15 marks)

Isolation and enumeration of phosphate solubilizing bacteria from soil.
Isolation and enumeration of Rhizobium and Azotobacter from soil.
Estimation of ammonifiers, nitrifiers and denitrifiers in soil.
Observation for Mycorrhizae.
Effect of pesticides on microbial activity.

Group – B : Environmental and industrial microbiology: (15 marks)

Potability of water (presumptive test) by MPN method.
Testing of water of sewage for DO, BOD, COD and CO_2.
Identification of enteric bacteria by IMViC test.
Alcohol production by fermentation.
Screening and isolation of amylase and antibiotic producing microbes from soil

Group – C : Analytical Microbiology: (25 marks)

Gel electrophoresis for determination of molecular weight of protein and DNA.
Isolation of plasmid DNA from bacteria by rapid method.

Group – D : Microbial growth: (15 marks)

Microbial growth experiments – Viable count of growing cultures and generation time determination.
Determination of microbial growth by turbidometric and cell count methods.
Study of growth curve of selective organisms by measurement of OD value. Effect of (i) temperature, (ii) pH, and (iii) osmotic pressure on bacterial growth.

Group – E : Excursion (Higher Institute/Industry): Report preparation and presentation. (5+5 = 10 marks)

Viva (10 marks)
Lab Note Book (10 marks)

Recommended books:

1. Microbiology, Authors: Pelczar, Chan and Kreig
2. Microbilogy – an Introduction, Authors: Tortora, G. J., Funke, B. R., Case, C. L.
3. General Microbilogy, Authors: Stanier R, Ingraham J, Wheelis M and Painter P.
4. Brock Biology of Microorganisms, Authors: Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl
5. Fundamental Principles of Bacteriology, Author: A. J. Salle
6. Textbook of Microbiology, Authors: Dubey and Maheshwari
7. Microbiology – Fundamentals and applications, Author: Atlas R. M
8. Introduction to Soil Microbiology Internationals. Authors: Martin Alexander
9. Microbiology, Authors: Prescott Lansing M. Harley John P. and Klein Donald A
10. Environmental Microbiology, Authors: N. S. Subbarao
11. Microbiology: Principels and Explorations, Author: Jacquelyn G. Black.
12. Prescott & Dunn's Industrial Microbiology, Author: G. Reed
13. Lehninger Principles of Biochemistry, Author: David L. Nelson & Michael M. Cox
14. Principles of Biochemistry, Author: Lehninger
15. Biochemistry, Author: Stryer, L.
16. Biochemistry, Author: Debajyoti Das
17. Biochemistry, Author: U. Satyanarayana & U. Chakrapani
18. Biophysics & Biophysical Chemistry, Author: D. Das
19. Fundamentals of Biostatistics, Author: V. B. Rastogi
20. Statistics in Biology & Psychology, Author: D. Das & A. Das
21. Computer Fundamentals, Author: P. K. Sinha and P. Sinha
22. Computer Fundamentals: Architecture and Organisation, Author: B. Ram
23. Molecular Cell Biology, Authors: Lodish, Berk, Zipursky.

24. Molecular Cell Biology, Authors: H. Lodish, A. Berk, L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell
25. Genetics, Authors: Peter J. Russell
26. Lewin's GENES X, Authors: Gardner, Simmons and Snustad
27. Mocrobial Genetics, Authors: Stanley R. Maly, John E. Cronan, David Freifelder
28. Genetics, Authors: P. K. Gupta
29. Cell Biology, Authors: G. Karp
30. Kuby Immunology, Authors: Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby
31. Fundamental Immunology, Author: W. E. Paul
32. Roitt's Essential Immunology, Authors: Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt
33. Industrial Microbiology, Author: Lester Earl Casida
34. Industrial Microbiology, Author: A. H. Patel
35. Experiments in Microbiology, Plant Pathology and Biotechnology, Author: K. R. Aneja
36. Practical Microbiology, Author: R. C. Dubey and D. K. Maheshwari
37. Introductory Practical Biochemistry, Authors: S. K. Sawhney and Randhir Singh