

**Syllabus for the Master of Science Course in**  
**MICROBIOLOGY**  
*Effected from 2006*  
(Semester Based)

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Vidyasagar University  
Midnapore – 721 102

## Content :

Semester	Paper	Subject (s)	Marks
<b>I</b>	I	Bacteriology	50
	II	Mycology & Phycology	50
	III	Biophysics and Instrumentation	50
	IV	Biochemistry	50
	V (Pract)	General Microbiology	50
	VI (Pract)	<b>Gr. A:</b> Analytical Biochemistry <b>Gr. B:</b> Group project	30 20
<b>II</b>	VII	Immunology & Virology	50
	VIII	Microbial Genetics and Molecular biology	50
	IX	Biomathematics	50
	X	Computer and Bioinformatics	50
	XI (Pract)	<b>Gr. A:</b> Review Work and Seminar <b>Gr. B:</b> Computer & Biomathematics	20 30
	XII (Pract)	<b>Gr. A:</b> Visit to Institute and preparation of report <b>Gr. B:</b> Microbial Genetics & Molecular Biology	20 30
<b>III</b>	XIII	Genetic Engineering	50
	XIV	Medical and Diagnostic Microbiology	50
	XV	Agricultural Microbiology & Plant Pathology	50
	XVI	Fermentation Technology and Industrial Microbiology	50
	XVII (Pract)	Medical and Diagnostic Microbiology	50
	XVIII (Pract)	Plant-microbes interaction	50
<b>IV</b>	XIX	Ecology & Environmental Microbiology	50
	XX	Advances in Microbial Technology, Food Technology and Nanobiology	50
	XXI (Pract)	Environmental microbiology and bioprocess technology	50
	XXII (Pract)	Comprehensive Viva	30
	XXIII (Pract)	Community / Industry survey and preparation of report	20
	XXIV (Pract)	Project Work	100

**N.B. 20% marks of each paper are allotted for Internal Assessment.**

# Semester - I

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## Paper I : Bacteriology

### Gr. A (25 marks)

1. Morphology and ultra structure of bacteria. Cell wall of archaeobacteria, gram negative, gram positive and acid-fast bacteria. Wall deficient organism including L-form. Cell wall synthesis. Cytoplasmic and outer membrane. Capsule - types, composition and function.
2. Structure and function of flagella, pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Nucleoid. Endospores.
3. Cultivation of bacteria: aerobic, anaerobic and facultative. Pure culture and its characteristics. Nutritional types, culture media used. Cell division (Gr. + ve and – ve), growth curve, generation time, asynchronous, synchronous, batch, continuous culture, measurement of growth and factors affecting growth. Control of bacterial growth - physical and chemical agents, preservation methods.

### Gr. B (25 marks)

1. Salient features of bacterial classification. Phylogenetic and numerical taxonomy. Modern trends of bacterial classification.
2. General idea about cyanobacteria, prochlorons and cyanelles.
3. Reserve food materials- polyhydroxybutyrate, polyphosphate granules, oil droplets, cyanophycin granules and sulphur inclusions.

## Paper II : Mycology & Phycology

### Gr. A : (25 marks)

1. Fungi : general features and classification including class characters of Zygomycotina; Ascomycotina; Basidiomycotina; and Deuteromycotina.. Heterothallism. Evolutionary trends and impact on ecosystem.
2. Life cycle – *Mucor*, *Saccharomyces*, *Aspergillus*, *Agaricus*,
3. Lichens and its importance.
4. Mycorrhiza - ecto, endo, and VA mycorrhiza.
5. Endophytic fungi and its utilities.
6. Industrial importance of fungi.

### Gr. B : (25 marks)

1. Algae: distribution, classification, thallus structure, nutrition and reproduction.
2. Details about green algae, diatom, euglenoids, brown algae, red algae, pyrophyta.
3. Life cycle of *Voucheria*, *Sargassum*, *Geledium*.
4. Economic importance and biotechnology of algae.

## Paper III : Biophysics & Instrumentation

### Gr. A : (25 marks)

1. Covalent and non-covalent bonds.
2. Properties of water.

3. pH and buffer. Buffer in biological system.
4. Structural organization of plasma membrane, model membrane, liposomes.
5. Law of thermodynamics, entropy and free energy concept.
6. Osmotic pressure, Donnan-membrane equilibrium.
7. Principle and application of tracer techniques in biology, radiation dosimetry, radioactive isotope and half life of isotopes, effect of radiation on biological system, autoradiography, cerenkov radiation, liquid scintillation spectrometry.

**Gr. B : (25 marks)**

1. Microscopy: Principle and applications of light, phase contrast, fluorescence, confocal, scanning, transmission, atomic force microscope.
2. Cytophotometry and flow cytometry. Principles of X-ray diffraction, fluorescence, UV, ORD/CD, visible, NMR and ESR spectroscopy.
3. Principle of protein purification method, ion exchange and affinity chromatography, electrophoresis, electrofocussing and ultracentrifugation. Protein crystallography. Methods of protein sequencing.
4. Principle and application of High Performance Liquid Chromatography, Gas Chromatography, Mass spectrometry, GC-MS.

## Paper IV : Biochemistry

**Gr. A: (25 marks)**

1. Structure, function and assembly of cellular components in prokaryotes.
2. Chemistry of amino acids, four level proteins structure, Ramachandran plot, protein folding and chemical modification of protein. Denaturation and renaturation of proteins structure.
3. Enzyme kinetics, regulation of enzyme activity, activators and inhibitors, Allosteric enzyme, ribozyme and abzyme.
4. Biophysical energy transduce, bioenergetics, electron transport chain and oxidative phosphorylation.
5. Bacterial membrane transport system.
6. Molecular basis of signal transduction in prokaryotes (quorum sensing) and eukaryotes.
7. Bacterial photosynthesis and its mechanism.
8. Metabolic patterns of photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs.

**Gr. B: (25 marks)**

1. Pathway and regulation of major metabolism - glycolysis (EMP pathway), TCA cycle, glyoxalate cycle, Entner-Daudoroff pathway, pentose phosphate cycle. Fructose-bisphosphate-aldolase pathway; Phosphoketolase pathway.
2. Metabolism of energy reserve compounds (polyglycans, polyhydroxy buteric acid).
3. Inorganic nitrogen metabolism. Assimilation of inorganic nitrogen. Glutamine, lysine and histidine biosynthesis.
4. Biosynthesis of fatty acids, degradation of fatty acids, biosynthesis of phospholipids and isoprenoids.
5. Purine and pyrimidine biosynthesis (de novo).
6. Coordinate control of metabolism.

## Paper V (Practical) : General Microbiology

### Gr. A : (25 marks)

1. Preparation of algal, bacterial and fungal media.
2. Qualitative and quantitative enumeration of microorganisms [algae, bacteria (aerobes and anaerobes) and fungi] from soil, water and air.
3. Study of algae: *Diatom*, *Volvox*, *Oedogonium*, *Laminaria*, *Anabena*.
4. Study of fungi: *Aspergillus*, *Saccharomyces*, *Agaricus*, *Puccenia*, *Alternaria*.
5. Germination efficiency of fungal spores.

### Gr. B : (25 marks)

1. Characterization of bacteria: (i) morphological: shape, Gram stain, endo-spore stain, capsule stain, acid-fast stain, flagella stain; (ii) cultural: growth in different carbon source (media); (iii) biochemical: catalase, peroxidase, amylase, indole, nitrate reduction, fermentation of sugar.
2. Enrichment culture technique for specific bacterial types: Nitrogen fixing, nitrifying, hemi-cellulose degrading, phosphate solubilizing.
3. Study of bacterial growth, kinetics, effect of inhibitors and stimulators on growth.
4. Assay of antibiotic (Streptomycin, Tetracycline), MIC & MBC.

## Paper VI (Practical)

### Gr. A : Analytical Biochemistry (30 marks)

1. Methods of cell breakage.
2. Estimation of total protein, carbohydrate, DNA and RNA of a bacterial cell.
3. Chromatography: Paper, TLC for sugar / lipid / amino acid.
4. Determination of activity of amylase, protease. Effect of pH, temperature on enzyme activity; Enzyme kinetics.
5. Purification of enzyme.
6. Determination of MW of protein by PAGE.
7. Study of enzyme by native gel electrophoresis (zymogram).
8. Isolation of phospholipids from liver and their separation by TLC.

### Gr. B : Group project (20 marks)

1. Biofertilizer / vermicomposting
2. Mushroom
3. Soil analysis (Biochemical and Microbiological)
4. Community health.
5. Air / water pollution.

## Semester - II

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### Paper VII : Immunology & Virology

#### Gr. A: [25 marks]

1. Events occurring immediately after the entry of the microorganisms in host in relation to establishment of infection. Growth in epithelial tissue, spread of intracellular organisms and tissue tropism etc. the encounter of the microbes with the phagocytes and cells of RE systems of body.
2. Pathogenicity of infection by microbes. Microbial strategies in relation to immune response. Mechanism of tissue injury in relation to bacterial infection : direct damage by microorganisms, microbial toxin, enzymes and indirect by inflammation.
3. Role of specific (like Ab and cell) and non-specific factors (like complement, interferon, acute phase protein), temperature in recovery, tissue repair and resistance to infection.
4. Primary and secondary immune responses to infection. Mechanism of lymphocyte activation. Role of lymphokines and other related factors in developments of humoral and cell mediated immune response.
5. Structure, variation and biological activity of antibody. Ag-Ab interaction (primary & secondary reactions). Genetic basis of antigen recognition (immunoglobulin and TCR diversity).
6. Out-line of hypersensitivity reaction. Autoimmunity. Idea about organ transplantation and tumor immunology.
7. Comparative immunology from fish to mammals.

#### Gr. B : [25 marks]

1. Virus : Brief outline of nomenclature and classification; distinctive properties; morphology and ultrastructure; capsids and their arrangements; types of envelopes and their composition; genome, their types and structures. Idea about viroids, prions.
2. Cultivation of plant and animal viruses.
3. Assay of viruses: physical and chemical methods (protein, nucleic acid, radioactive tracers, electron microscopy). Infectivity assay (plaque method, end point method).
4. Morphology, genetics and reproduction of M13, T4, Cauliflower Mosaic virus, Potato virus X, Rota virus, HIV.
5. Antiviral drugs.

### Paper VIII : Microbial genetics & Molecular biology

#### Gr. A: [25 marks]

1. Basic principles of Heredity. The law of DNA constancy and C-value paradox. Chromosome structure and function. Nucleoproteins, Histones. Extra chromosomal genetic material. Transposons – types and function.
2. Structural polymorphism of DNA and RNA. Structure and organization of gene.
3. Genomics: Structural genomics; genetic maps; physical maps. Human Genome Project. Functional genomics: function prediction; gene expression and microarrays, reporter sequences, genomewide mutagenesis. Comparative genomics of prokaryote and eukaryote.
4. Bacterial gene transfer and mapping: conjugation, transformation, transduction.

5. Molecular recombination. Linkage and genetic mapping.
6. Regulation of prokaryotic gene expression : lac and trp operon. Lytic & lysogenic regulation in phage virus.
7. Regulation of gene expression in Eukaryotes. Epigenetics.

**Gr. B: (25 marks)**

1. DNA replication, transcription and translation. Post transcriptional (capping, polyadenylation, splicing, intron and exons) and post translational modification.
2. DNA damage and repair : photoreactivation, excision, mismatch, SOS repair. DNA methylation, heterochromatization, transposition. Site directed mutagenesis.
3. Cancer and molecular mechanism of oncogenesis.

## **Paper IX : Biomathematics**

**Gr. A: (25 marks)**

1. Basic Calculus, limit, derivative and integration.
2. Mathematical modeling of bacterial growth curve, fermentation, microbial genetics, control of microorganism.

**Gr. B: (25 marks)**

1. Definition of sample and population, concept of variable, Frequency distribution & its graphical representation, Recapitulation of mean, median, mode, standard deviation, standard error.
2. Probability distribution (normal, binomial and poisson).
3. Tests of statistical significance. Simple correlation and regression, .t-test, Analysis of variance.

## **Paper X : Computer & Bioinformatics**

**Gr. A: (25 marks)**

1. General mode of computer system. Generation of computer. Brief description of various components of computer. Function of an operating system. Types of operating systems. Basic knowledge about various programming languages and packages.
2. Fundamentals of WINDOWS.
3. Introduction to C.

**Gr. B : (25 marks)**

1. Introduction to bioinformatics.
2. Biological sequence database.
3. Sequence comparison, pairwise alignment, multiple alignment.
4. Mutation matrix and its application.
5. Database searching, algorithms of FASTA and BLAST.
6. Basic molecular phylogeny.

## **Paper XI : (Practical)**

**Gr. A: Review work and seminar (20 marks)**

**Gr. B: Computer & Biomathematics (30 marks)**

1. Working knowledge of WINDOWS.
2. Operation Microsoft word, Microsoft excel, Microsoft Power Point and internet.
3. Preparation of graph of experimental data using MS Excel.
4. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using C.
5. Testing of significance.
6. Pair wise alignment, multiple alignment and data-base searching.

## **Paper XII : (Practical)**

**Gr. A: Visit to Institute and preparation of report (20 marks)**

**Gr. B: Microbial genetics & molecular biology (30 marks)**

1. Isolation of mutant (UV/ NTG / HNO<sub>2</sub> / Dyes) .
2. DNA isolation (plasmid & chromosomal).
3. Agarose gel electrophoresis for DNA.
4. Amplification of DNA / RNA by PCR.
5. Restriction analysis of bacterial DNA.
6. Study of transformation process.
7. Induction of  $\beta$  –galactosidase in *E. coli*.
8. Enumeration of bacteriophage.

## Semester - III

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### Paper XIII : Genetic Engineering

#### Gr. A: [25 marks]

1. Principles and procedures of protein and nucleic acid sequencing, southern, northern and western blotting, polymerase chain reaction, gel electrophoresis, synthesis of gene.
2. Isolation and selection of suitable gene – from known specific proteins, with tissue specific expression, coding for unknown product, transposon tagging, mutant complementation, chromosome walking.
3. Vehicles for gene cloning – plasmid and bacteriophages. Yeast vectors development – Yep, YRP, Yip, YAC (yeast artificial chromosome), retrovirus like vector (Ty) in yeast, shuttle vector.

#### Gr. B: [25 marks]

1. Cloning – restriction enzymes, joining of DNA fragments, construction of chimeric DNA, molecular probes. Construction and screening of genomic and cDNA libraries.
2. Gene transfer methods – *Agrobacterium* mediated gene transfer, direct gene transfer - liposomes, electroporation, particle gun, microinjection.
3. Application of genetic engineering - in medicine, agriculture, forensic science, environment.
4. Transgenic animals and plants.

### Paper XIV : Medical and Diagnostic Microbiology

#### Gr. A: [25 marks]

1. Man-microbes interaction - normal microflora in human body and their beneficial effect. Parasites and pathogenesis in human health and disease.
2. Epidemiology, symptomatology. General description of microbial pathogens, diagnosis, prevention and therapy of - microbial food poisoning, meningitis, tuberculosis, leprosy, urinary tract infection, cholera, ring-worm, syphilis, diphtheria, mycotoxicosis, opportunistic fungal pathogens, dermatophytes.
3. Hospital acquired pathogens and their prevention. Management and biosafety.
4. Life cycle, pathogenesis of malarial parasite, *Giardia* and *Leishmania*.

#### Gr. B: [25 marks]

1. Disease control by vaccination, national vaccination schedules. Types of vaccine : live microorganism, attenuated organism, genetically modified organism, protein, edible, synthetic, naked DNA, recombinant and anti-idiotypic vaccine. Hazards of immunization
2. AIDS: HIV testing, vaccine design.
3. Immunohaematology – blood groups, blood transfusion and Rh incompatibilities.
4. Epitope design and its application in immunodiagnosis tests. *In vitro* diagnostic methods – agglutination, precipitation, complement fixation, immunofluorescence, ELISA, radio-immunoassay, FACS. *In vivo* diagnostic methods – skin test and immune complex tissue demonstration.
5. Monoclonal antibody - production and application.
6. Enzyme immuno histochemical methods. Enzyme immuno - assays after immuno blotting.

## Paper XV : Agricultural Microbiology & Plant Pathology

### Gr. A: (25 marks)

1. Plant-microbes interaction – beneficial association between plant and microorganisms. Different symbiosis including rhizosphere and phyllosphere microorganisms and their effect.
2. Important fields in soil microbiology: nutrient transformations, organic matter cycling, mycorrhizae.
3. Rhizosphere, phyllosphere, Biochemical basis of nitrogen fixation (symbiotic and asymbiotic), N<sub>2</sub> cycling.
4. Biofertilizer: Types, production and application (*Rhizobium*, *Azotobacter*, *Azolla*).
5. Biopesticides – type, production (BT) and application.
6. Microbial association in composting: Farmyard manure, Method of composting (aerobic, anaerobic), enrichment of compost with microbial inoculants. Super digested compost.
7. Vermiculture: Vermiculture process, Vermicomposting materials, Advantages of vermicompost.
8. Concept of plant tissue culture, micropropagation and protoplast technology.

### Gr. B: (25 marks)

1. Plant pathology: host range of pathogens, Koch's rules; parasitism and pathogenicity, stages in the development of disease (mechanical forces exerted by pathogens on host tissues, chemical weapons of pathogens – enzymes, toxin, growth regulator, polysaccharides), significance of plant diseases.
2. Plants defence mechanism: structural and chemical defenses. Detoxification of pathogen toxin, immunization of plants against pathogens, Local and systemic acquired resistance, Development of genetically engineered disease resistance plant. Horizontal and vertical resistance.
3. Idea of some plant pathogens: *Alternaria*, *Fusarium*, *Puccinia*, *Xanthomonas*, *Rice tungro virus*.

## Paper XVI : Fermentation Technology & Industrial microbiology

### Gr. A: (25 marks)

1. Types of Fermentation; bioreactor configurations: stirred tank, bubble column, airlift reactor, stirred and air driven reactors, packed bed, fluidized bed, trickle bed; monitoring and control of bioreactors; Ideal reactor operation: batch, fed-batch, and continuous operation.
2. Sterilization of bulk medium and fermentor.
3. Fluid flow and mixing: classification of fluids, viscosity, non-Newtonian fluids, Rheological properties of fermentation broth; heat transfer; mass transfer: molecular diffusion, oxygen uptake in cell culture, oxygen transfer in fermentor ( $k_L a$ ), measurement of  $k_L a$ ;
4. Bioprocess engineering: Bioprocess development; stoichiometry of growth and product formation; energy balances: basic energy concept, energy balance equation for cell culture. homogeneous and heterogenous reactions.
5. Down stream processing: filtration, centrifugation, cell disruption, ideal stage concept, aqueous two-phase liquid extraction, adsorption, chromatography;
6. Solid-state fermentation : process and application.
7. Factors depending on scale up process of fermentation.

**Gr. B: (25 marks)**

1. Isolation, selection and utilization of industrial microbes.
2. Improvement of Industrial strain; its preservation and maintenance.
3. Types and development of inoculum.
4. Production of microbial enzymes (protease, lipase), antibiotics (streptomycin, tetracycline), steroids, organic acids (citric acid, acetic acid) and solvents (alcohols).
5. Production of beer and wine.
6. Immobilization: Enzyme and whole-cell.
7. Concept of Intellectual Property Right and patent formulation.

**Paper XVII (Practical): Medical and Diagnostic Microbiology**

**Gr. A: (25 marks)**

1. Separation and characterization of blood cell.
2. Estimation of TC & DC.
3. Separation of macrophage and examination of phagocytosis.
4. Rising of antisera in animals. Ouchterlony double diffusion technique.
5. Quantification of immunoglobulins by ELISA.
6. Precipitation techniques : immunodiffusion, immuno electrophoretic method.
7. Agglutination reactions : Widal, Haemagglutination
8. Estimation of blood sugar, urea, SGOT & SGPT.

**Gr. B: (25 marks)**

1. Identification of *E. coli*, *P. auriginosa*, *S. aurious*, *Salmonella* sp by biochemical tests.
2. Identification of pathogenic fungi *Aspergillus niger* and *Candida albicans*.
3. Detection of endotoxin by LAL test.
4. Enumeration, identification and antibiotic sensitivity of microbes associated with urine / pus.

**Paper XVIII (Practical) : Plant - Microbes Interaction**

**Gr. A: (25 marks)**

1. Production of vermicompost. Enumeration of microbes and level of N, P, & K before and after composting.
2. Isolation of VAM spores from soil and study of Mycorrhiza.
3. Isolation and cultivation and application of *Rhizobium*, *Azotobacter*.
4. Measurement of N<sub>2</sub> fixing capacity of microbes using gas chromatography / total N<sub>2</sub> estimation by Kjeldahl method.
5. Anatomical and microbial study of legume nodule.
6. Production and estimation of IAA from microorganism.

**Gr. B: (25 marks)**

1. Isolation of fungal pathogen from diseased plant specimen.
2. Study of virus infected plants: study of inclusion bodies in viral infected plants; study of stomatal nature in virus-infected plants; biochemical tests for plant pathogens.
3. Identification of pathological plant specimen (Demonstration of sheet preparation).

## Semester - IV

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### Paper XIX : Ecology & Environmental Microbiology

#### Gr. A: (25 marks)

1. Environmental complex, interaction of ecological factors: light, temperature, precipitation (rainfall), humidity of air, atmospheric gases and wind; topographical factors; edaphic factors.
2. Concept of ecosystem and ecosystem management, trophic structure of the ecosystem; ecotones and edges; ecosystem diversity; classification of ecosystems; stability of ecosystem; examples of ecosystem: A pond; agroecosystem.
3. Energy flow through ecosystem, energy environment. Concept of productivity; energy partitioning in food chain and food webs;
4. Population properties, density dependent and density independent mechanism of population regulation; population growth curve; population genetics: a brief idea.
5. Types of interactions between two species; co-evolution. Biodiversity.

#### Gr. B: (25 marks)

1. Extremophile: acidophile, alkalophile, thermophile, barophile; Community structure and organization. Effect of heavy metal and xenobiotic substances on microbes; biological magnification of toxic substances.
2. Aeromicrobiology: Microbes of indoor and outdoor environment, pathways, enumeration, Extramural and intramural, control, bioterrorism. Eutrophication, Biosafety.
3. Water microbiology: Significance of microbes in water quality. Microbes related to fish growth. Common microbial diseases of fish. Test for portability of water. Microbial treatment of sewage (domestic and industrial); application of wastewater in land; composting of biosolids and domestic solid waste.
4. Marine bacteria and their applications.
5. Microorganism and metal pollutants; biodegradation of TNT, PCB; Bioremediation: bioventing, biofiltration, bioaugmentation, problems and advantages

### Paper XX : Advances in Microbiological Technology, Food Microbiology and Nanobiology

#### Gr. A: (25 marks)

1. Single cell protein, mushroom cultivation and application.
2. Fermented beverages.
3. Development of non-toxic therapeutic agent from microbial origin.
4. Probiotics: Application for curing enteric disease and induction of host immunity. Utilization of probiotics in aquaculture for development, nutritional indices and immunity of fishes.
5. Production of biopolymer and bioplastic.
6. Steroid biotransformation for preparation of useful drugs.
7. Stem cell and its application.

**Gr. B: (25 marks)**

1. Microorganisms associated with food, food detritions by microbial toxins, Principles of food preservation. Canning, Processing for Heat treatment –D, Z and F values.
2. Fermented food: Production and application. Oriental fermented food.
3. Importance of lactic acid bacteria.
4. Fermented dairy products, vegetables, vinegar, cheese.
5. Bacterocins and its application.
6. Natural colours as food additives.
7. Introduction and applications of Nanobiology. DNA based nano-structure, Nanomedicine.

**Paper XXI (Practical) : Environmental microbiology and Bioprocess technology**

**Gr. A: (25 marks)**

1. Testing of water sample to determine microbial load in the different places of urban/ rural locality. Enumeration of coliform bacteria (total and fecal) of water through multiple tube fermentation technique (MPN).
2. Determination of Biochemical Oxygen Demand (BOD)
3. Identification of enteric bacilli by IMViC Test.
4. Determination of phosphatase activity of milk.

**Gr. B: (25 marks)**

1. Production of alcohol by fermentation from molasses.
2. Preparation of bakers yeast using molasses.
3. Microbial production of amylase (Solid, Liquid & Submerged fermentation).
4. Production of card with respect to microbial load and organic acid formation.

**Paper XXII (Practical)**

**Comprehensive Viva (30 marks)**

**Paper XXIII (Practical)**

**Community / Industry survey and report preparation (20 marks)**

**Paper XXIV (Practical)**

**Project work (100 marks)**

**[Students have to complete their training cum dissertation work in different national institutes/ laboratories/ Universities / industries within a tenure of 3 months]**