TOTAL MARKS: 1600
CREDITS-96

Semester 1: TOTAL MARKS: 400

PAPER 1: BASIC CLASSICAL MICROBIOLOGY

THEORY: 70 MARKS **60END SEM+10CIA**

- **MODULE 1**:

Taxonomy & Diversity of Life forms (35 MARKS)

Morphology: Morphological features of algae, fungi, bryophyte and pteridophyte and their evolution considering the molecular characterization. Economic importance of these members.Anatomy and morphology of gymnosperms and angiosperms, brief idea of their development and morphogenesis including APC systems. Concept of Chemotaxonomy. (**AKM**)

Taxonomy: Taxonomic principles, Taxonomic hierarchy, Binomial nomenclature, types of bacterial classification systems, new approaches to bacterial taxonomy (numerical taxonomy, ribotyping, rRNA sequencing, fatty acid profile) Bergey's Manual of Determinative Bacteriology, Bergey's manual of systematic bacteriology. Phenetic, phylogenetic and polyphasic approach to taxonomy. molecular chronometers**. (MM)**

Microbial diversity - The expanse of microbial diversity, phylogenetic trees and three domain universal phylogenetic trees. Measures and indices of diversity. General characteristics of various groups of prokaryotes: Archaebacteria, Eubacteria ,mycoplasmas, rickettsiae, chlamydiae, spirochaetes, cyanobacteria, actinomycetes**. (DD)**

Methods of studying microbial diversity (Conventional and molecular tools) - Concept of 'unculturable' Strategies for culture of 'unculturable' bacteria. Culture independent molecular methods for identifying unculturable bacteria. Methods of extracting total bacterial DNA from a habitat and metagenome analysis. **(MM+DD)**

- **MODULE 2:**

Physiology of Microbes and Plants (35 MARKS)

Water relations, mineral nutrition, nitrogen, phosphorus and sulpher metabolism, stomatal physiology, source and sink relationship, physiology and biochemistry of seed dormancy and germination, hormonal regulation of growth and development. Photoregulation, growth responses, physiology of flowering, senescence.Plant breeding principles, important conventional methods of breeding of self and cross pollinated and vegetatively propagated crops. Non-conventional methods, mutation breeding. (AKM)

Introduction to Microbial Physiology: The *E.coli* Paradigm, Metabolic genetic regulation, Energy, oxidation-reduction vs. fermentation. **Microbial growth**: Growth cycle, continuous culture, factors affecting growth, details of synchronous and Diauxic growth curve. Fermentation pathways in specific group of microorganisms: Lactic acid, propionic acid, butyric acid producing fermentation; **Bacterial Sporulation-** Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation. (MM)

Nutritional classification of microorganisms- Classification of microorganisms based on carbon source, energy source and electron sources. Macro & micronutrients. Energy generation in cyanobacteria, green bacteria, purple sulphur bacteria and chemolithotrophs. **Introduction to two component system**, regulatory systems during aerobic-anaerobic shifts. Osmotic control of gene expression, SOS response and Heat shock response, regulation of nitrogen assimilation and fixation, Phosphate starvation, controlled stimulon, oxidation stress, The Lon system (Proteolytic control) (AB)

PRACTICAL: 30 MARKS 20CIA+ 10 END SEM

Basic Microbiology Practicals (AKM+MM+DD)

1. To learn pure culture techniques used for isolation and purification of microorganisms. a. Streak plate method. b. Pour plate method. c. Spread plate method
2. To perform different staining methods to study morphological and structural characteristics of bacteria and fungi. a. Gram Staining. b. Acid fast staining. c. Fungal staining (Lacto-phenol cotton blue). d. Spore staining. e. Flagella staining. f. Capsule staining. g. Negative staining

Microbial physiology practicals (AB+MM+AKM)

1. To study catalase activity of given microbial culture.
2. To study oxidase activity of given microbial culture.
3. To study ability of microorganisms to hydrolyse casein
4. To demonstrate phenylalanine deaminase activity of given bacterial culture.
5. To demonstrate L-lysine decarboxylase activity of bacterial culture.
6. To demonstrate Fat hydrolysis (lipase activity) by bacteria
7. To demonstrate the diauxic growth curve of bacteria.
8. To determine the thermal death point and thermal death time of a microbial culture.
9. Differentiate between plant parasite and other phyloplane organism

REFERENCE:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verla
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education
7. Lee (2018) Phycology, Cambridge University Press.
8. Mitra and Chakraborty (2021) Mycology and Phytopathology Taurean Publishers.
9. Shaw and Goffinet (2000) Bryophyte Biology. Cambridge University Press.
10. Sharma (2006) Pteridophyta, Sharma. McGrawHill.
11. Byng (2015) Gymnosperm Handbook.Plant Gateway.
12. Soltis (2005) Phylogeny and Evolution of Angiosperms. University of Chicago Press.
13. Mitra (2014) Applied Plant Physiology. Book Syndicate Pvt. Ltd.
14. Brown and Caligari (2008) An Introduction to Plant Breeding. Blackwell Publishing.
15. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall International Inc.
1. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
2. Reddy SR and Reddy SM. (2005). Microbial Physiology.
3. Albert G. Moat, John W. Foster, Michael P. Spector. Microbial Physiology 4th ed.

PAPER 2: BIOINSTRUMENTATION AND BIOENERGETICS

THEORY 70 MARKS

- **MODULE 1 (35 MARKS)**

Bioinstrumentation

Physico-chemical techniques: Centrifugation: Basic principle, types and application of preparative centrifuge. Chromatography: Principle and application of partition, gel filtration and affinity chromatography. Introduction to HPLC. Electrophoresis: Types, principle and application.Viscosity: Introduction to viscosity and principle of Ostwald viscometer **Microscopy and application**-Basic idea of light diffraction, polarization, fluorescence. Basic principle and applications of bright-field, dark-field, phase contrast, DIC microscopy. Introduction to Confocal, evanescent field, Super-resolution and Electron microscopy **Spectroscopic methods:**Basics of UV-Visible, Fluorescence, IR spectroscopy (**RM**)

- **MODULE 2 (35 MARKS)**

Energy metabolism

Photosynthesis: Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, Organization of photosystem I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water. Bacterial photosynthesis: scope, electron carriers,

Photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria, electron donors other than water in anoxygenic photosynthetic bacteria.**Chemolithotrophy-** Basic mechanism of ATP synthesis, Reverse and forward electron flow. Chemolithotrophic bacteria- Different types namely ammonia oxidizers, methanogens, nitrite oxidizers, hydrogen oxidizers, iron oxidizers and Sulphur oxidizers. **Degradation of carbohydrate:** Glucose Metabolism– EMP pathway, hexose monophosphate pathway, Entner-Doudoroff pathway, Phosphoketolase (PK) pathway, TCA cycle, gluconeogenesis, Feeder pathways for glycolysis. **Degradation of proteins and amino acids:** protein turnover; flow of nitrogen into biosynthesis and catabolism of amino acids (with reference to representative examples phenylalanine, tyrosine, tryptophan, arginine, alanine, glycine, glutamic acid, glutamine); central role of glutamine. **Degradation of nucleic acids:** metabolism of purines and pyrimidines; urea cycle and the excretion of nitrogen. **Degradation of Fatty acid**: Oxidation of fatty acids, β oxidation; biosynthesis of fatty acids and cholesterol (outline); ketone bodies. Integration of metabolism and metabolic regulation with reference to metabolic pool.**Metabolism of energy reserve compounds**: Polyglycans, Poly- and β-hydroxybutyrate, nitrogenous and non-nitrogenous compounds- synthesis and degradation in bacterial cells.**Electron transport chain and oxidative phosphorylation:** Aerobic and anaerobic respiration (electron transport, oxidative phosphorylation, regulation of ATP production); Fermentation- homolactic, heterolactic, mixed acid, Cori cycle. (**KS+AB**)

PRACTICAL: 30 MARKS

1. TLC and Column chromatographic assays
2. Use of differential centrifugation to purify cell extracts
3. Separation of proteins using SDS-PAGE
4. Getting acquainted with a compound microscope-Basics of light microscopy
5. Use of UV-Vis spectrophotometer in biology
6. photosynthesis assay
7. problems of Bioenergetics

REFERENCE:

Lehninger Principles of Biochemistry, Nelson & Cox.
Biochemistty, Voet and Voet.
Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

PAPER 3: MICROBIAL CELL BIOLOGY

THEORY : 70 MARKS

- **MODULE 1**: **Microbial cellular structure (35 MARKS)**

Morphology and ultra structure of bacteria: size, shape, and arrangement of bacteria, ultra structure of bacterial cell wall of eubacteria and archeabacteria. Protoplast and spheroplast formation and L-form. **Bacterial Cell wall**: structures, diversities and biosynthesis, different cell wall hydrolyzing enzymes; **Bacterial endospores**: structure, formation and germination; **Uncommon bacterial genera**: Rickettsia, Chlamydia, Mycoplasma, sheathed bacteria, stalked and budding bacteria, gliding bacteria including Myxobacteria. **Structures external to cell wall** – Capsule, Flagella, Pili, Sheath, Prostheca, Stalks. (DD+MM)

Cell membrane structure; membrane constituents; phospholopids, glycolipids, cholesterol, membrane proteins, receptors and phospholipases; bilayer structure, asymmetry, fluid mosaic model of random diffusion of membrane components, domains in membrane- natural and artificial membranes (SSC)

- **MODULE 2**: **Microbial Cellular function (35 MARKS)**

Quorum sensing: Overview of quorum sensing, Quorum sensing and cooperation, Quorum sensing and competition, Quorum sensing in Biofilm formation, Applications of Quorum sensing (MMG)
Microbial stress physiology (extremophiles) and lipid raft dynamics and function Different types of **secretion systems** in microorganisms. (AKM)
Cell signalling - General principles of cell communication, Types of receptors- extracellular and intracellular. G-protein,signaling through G-protein coupled receptors, enzyme linked cell signalling, signal transduction pathways, second messengers, regulation of signalling pathways, bacterial chemotaxis (MM)
Functional aspects of membrane Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion, Proton Motive Force, role of permeases in transport, different permeases in *E. coli*. Transport of amino acids and inorganic ions in microorganisms and their mechanisms. (SSC)
Practical: 30 MARKS
Determination of EPS and its characterization, Heavy metal immobilization, Siderophore production and characterization. Cell wall stripping, Plasmid curing.
To check motility of bacteria by hanging drop and semi-solid agar methods.
To cultivate bacteria in aerobic and anaerobic conditions.
Identification of a prokaryotic and eukaryotic cell by preparation of slides.
UV Survival curve of *E.coli*. or any other bacteria.
Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on spore germination of *Bacillus* sp.
Isolation of Photosynthetic bacteria.
To cultivate bacteria in aerobic and anaerobic conditions.
To check motility of bacteria by hanging drop and semi-solid agar methods.

REFERENCE:
Review papers on Quorum sensing
Mitra, Dutta and Roy (2018) Comprehensive Microbiology. Current Books International, Kolkata.
Bruce Alberts, Alexander Johnson, Martin Raff, Julian Lewis, Keith Roberts, Peter Walter, Dennis Bray, James D. Watson. Molecular biology of the cell.
Harvey Lodish, David Baltimore. Molecular Cell Biology
Gerald Karp. Cell Biology
Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms

Paper 4: ENZYMOLOGY AND CHEMICAL KINETICS
THEORY 70 MARKS

- **Module 1**: **Enzymology (35 MARKS)**

General Features of Enzyme Catalysis, Different Theories of Enzyme Catalysis, Catalytic Strategies, Detailed Study of a Model Enzyme to Understand Various Catalytic Strategies.Enzyme Kinetics: Hyperbolic Kinetics, Concept of Enzyme-Substrate Complex, Equilibrium Assumption and Michaelis-Menten Equation, Concept of Ks, Steady State Assumption and Briggs-Haldane Equation, Concept of Km, Turnover Number, Catalytic Efficiency, Kinetic Perfection, Linearized Plots: Lineweaver-Burk, Eadie-Hofstee and Hanes Plots, Bisubstrate Kinetics, Kinetics of Enzyme Inhibitions, Numericals on Enzyme Kinetics.Enzyme Regulation: Effect of Temperature and pH, *in vivo* Strategies of Regulation, Allosteric Enzymes and their Regulation. (JG)
Ribozyme (catalytic RNA), Abzyme and Isozyme, Active site determination studies. Industrial application of several enzymes. (SSC)

- **Module 2: Thermodynamics and Reaction Kinetics (35 MARKS)**

Concept of Rate, Purpose of Studying Reaction Rate, Factors Influencing Reaction Rate, Role of a Catalyst, Theories of Reaction Rate: Collision Theory – Arhenius Equation, Transition State Theory –

Eyring Equation, Simple Techniques to Measure Reaction Rates, Rate Law, Rate Constant, Order, Experimental Determination of Rate Laws, Importance Initial Rate, Average and Instantaneous Rates, Integrated Rate Laws, Features of Zeroth, First and Second Order Reactions, Concept of Half-Life, Reaction Mechanisms, Rate Determining Step, Molecularity, Thermodyamic vs. Kinetic Control, Numericals on Integrated Rate Laws and Arhenius Equation.Basic Concepts: First and second laws of Thermodynamics, Definitions and Significances of Gibb's Free Energy, Enthalpy and Entropy and their Changes, and Mathematical Relationship among them, Thermodynamics of Folding and Unfolding of Macromolecules, Standard Free Energy Change and Equilibrium Constant, Thermodynamics of Membrane Transport, Donnan Membrane Equilibrium, Energy rich compounds, Coupled reactions and additive nature of standard free energy change. (JG)

Practical: 30 MARKS

1. Thermodynamics: Numericals on Biological Thermodynamics
2, Chemical Kinetics: Numericals on Chemical Kinetics
3. characterization of enzymes from microbial, plant, animal sources-beta D glucosidase from E.coli, cellulase from fungi, polyphenol oxidase from leaves, alkaline phosphatase from chicken liver
4. Determination of kinetic parameters of enzymes
5. Case study on industrially relevant enzyme (microbial source)
6. Enzyme assay of certain extremophiles and anti-oxidant properties and recyclable properties

REFERENCES

1. Biochemistry by Garret and Grisham
2. Biochemistry by Voet and Voet
3. Biochemistry by Stryer
4. Biochemistry by Lehninger
5. Understanding Enzymes by Palmer
6. Physical Chemistry for Life Sciences by Atkins and Paula.
7.Salwan and Sharma (2020) Physiological and Biotechnological aspects of Extremophiles. Academic Press.

SEMESTER 2: TOTAL MARKS 400

PAPER 5-ENVIRONMENTAL MICROBIOLOGY

THEORY: 70 MARKS

- **Module 1**: **Environmental Microbiology (35 MARKS)**

Water microbiology: Distribution of microorganisms in the aquatic environments: fresh water and sea water microflora. Microorganisms and water quality, water pollution. Water purity test and indicator organisms, method used in environmental studies –BOD, COD, DO. Common water borne disease and their control measure. Water purification: flocculation, chlorination and purification. Assessment of microbial status in water and waste water. **Microbiology of wastewater** and solid waste treatment: - Waste types-solid and liquid waste characterization, primary, secondary and tertiary treatments : trickling filter, oxidation ponds and stabilization ponds , principle of aerobic and anaerobic digestion.**Microbial biofilms:** physiology, morphology, biochemistry of microbial biofilms, mechanism of microbial adherence, beneficial and harmful role of biofilms.**Bioremediation** of contaminations (MM)

Biology of atmosphere: Source and kinds of microorganisms present in the atmosphere, techniques for microbiological sampling of air. Air-borne disease and their control.(AKM)

- **Module 2**: **Soil and Agriculture Microbiology (35 MARKS)**

Biology of lithosphere: Soil as a habitat for microorganisms, methods of studying microorganisms and their activities in soil. Increasing soil fertility by chemical and bio fertilizer. Biology and biochemistry of N_2-fixation, Biochemical transformation of inorganic and organic nitrogen compounds. Microbial degradation of cellulose, hemicelluloses, lignin, xylans, starch and pectin. Biodegradation of petroleum hydrocarbons, pesticides, herbicides and xenobiotics, Bioleaching [DD]

Bioremediation: Metal-microbe interactions, Microbial control of pollution by microbes POPs and heavy metals [AKM]

Agricultural Biology: Rhizosphere and phyllosphere micro organisms and their interactions with plants. Plant pathogen (bacterial and fungal) Mechanisms of plant pathogenicity, symptoms of plant diseases, transmission of plant diseases. Signalling events in pathogenesis and resistance to pathogens. Molecular basis of plant disease control along with cultural practices, chemical control and biological control. Microbial control of insects. Beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungus). Biopesticides and biocontrol agents. SAR and ISR. Integrated Pest Management. [AKM]

Practical 30 MARKS

Isolation of microbes from soil, air and water by specific methods, their characterization, interaction, Role of PGPR and their importance on plant growth. Identification on the basis of morphology and cultural characteristics.(AKM)

WATER MICROBIOLOGY (MM)

Determination of the Most Probable Number [MPN] of coliform bacteria.

Confirmatory Test for the presence of coliform bacteria after MPN Test

Determination of Dissolved oxygen[DO] and Biochemical oxygen demand [BOD] in water sample

Determination of COD of the water sample.

To estimate the amount of chlorine present in water sample by titration method.

Measurement of microbial activity in soil by soil respiration method.

Determination of total alkalinity of a water sample.

REFERENCE:

1. Mitra and Chakraborty (2021) Mycology and Phytopathology. Taurean Publishers New Delhi.
2. Rangaswamy and Bharadwaj (2015) Agricultural Microbiology. PHI Learning Pvt. Ltd.
3. Aithal, Wakte and Manwar(2010) Air Microbiology. Cinamonteal Publishers.
4. Charles P. Gerba, Ian L. Pepper. Environmental Microbiology
5. Pradipta K. Mohapatra. Textbook of Environmental Microbiology
6. Larry L. Barton, R.J.C. McLean. Environmental Microbiology and Microbial Ecology

PAPER 6: Molecular Biology and RDT

THEORY 70 MRKS

- **Module 1: Molecular Biology (35 MARKS)**

Replication: Basic Features of Prokaryotic DNA Replication, Comparison with the Eukaryotic Counterpart.

Transcription - RNA polymerases in prokaryotes and eukaryotes, Transcription signals, Promoters and Enhancers, Initiation and Elongation of RNA synthesis, Rho dependent and Rho independent termination, Transcription factors in Eukaryotes, Prokaryotic and Eukaryotic Transcription. Experiments in support of the events .Major shifts in Bacterial Transcription

Translation: Basic Features of Prokaryotic Translation, Comparison with the Eukaryotic Counterpart.

- **Module 2:**

Recombinant DNA Technology (RDT) (35 MARKS)

Principles and methods of recombinant DNA technology- hybridization, cloning, sequencing, polymerase chain reaction, genome projects; gene manipulations; cloning in *E.coli*, plasmids, Yeast two hybrid system, Mammalian Expression vectors. Construction and comparison of genomic and cDNA library, reverse transcription, Genome mapping, DNA fingerprinting, Phage display.

Practical: 30 MARKS

Isolation of bacterial genome and plasmid DNA,

restriction enzyme digestion,

restriction mapping and

cloning

REFERENCES:-

Benjamin Lewin (2013) Genes IX . Jones and Bartlett publishers
Watson,J.D., Hopkins,N .H ., Roberts, J.W., Steitz,J.A and Weiner,A.M(1987). Molecular Biology of the Gene . Benjamin-Cummings, Menlo Park California.
Molecular Biology: Robert Weaver
Molecular Biology :David Clark
Lehninger Principles of Biochemistry - Cox & Nelson
Biochemistry - Voet and Voet.
Biochemistry Berg – Tymoczko & Stryer
Principles of Gene Manipulation & Genomics-Primrose &Twyman.
Glick,B.R., Pasternak, J.J.(2003) Molecular biotechnology 3 rd edition.ASM Press
Brown T.A.(2010) Gene Cloning & DNA Analysis 6 th edition. Wiley-Blackwell Publishers 4.
Sambrook, J and Russell,D.W.(2001) Molecular Cloning : a laboratory manual 3 rd edition. Cold Spring Harbor laboratory Press
Molecular Biology of the Gene by Watson *et al*
Genes XI by Le

Paper 7: Food Microbiology and Industrial microbiology

THEORY 70 MARKS

- **Module 1: Food Microbiology (35 MARKS)**

Microorganisms important in food microbiology: molds, yeast and bacteria –general characteristics, classification and importance. Factors influencing microbial growth in food: Extrinsic and intrinsic factors.Sources of microorganisms in milk and types of microorganisms in milk. Microbiological examination of milk (standard plate count, direct microscopic count, reductase, and phosphatase test).

Microorganisms as source of food: Single Cell Protein (SCP), fermented milks, fermented vegetables, fermented meat and fish.

Microbiological examination of food: Sample collection, preparation and analysis techniques-cultural and non cultural techniques, Rapid methods of detection and Laboratory Accreditation.

Microbiology of Food Preservation – Heat processing, high pressure processing, irradiation, low temp. storage, chemical preservatives control of water activity.

Bacterial agents of food borne illness – Food infection and intoxication by bacteria

Non- bacterial agents of food borne illness – protozoa, Helminths and nematodes, Toxigenic algae and fungi, Mycotoxins, food borne viruses.

Controlling the microbiological quality of food – Control at source, HACCP system, quality systems like ISO 9000 series. (DD+MM)

- **Module 2: Industrial microbiology (35 MARKS)**

Industrially important strains of bacteria, fungi, and actinomycetes. Novel microbes for future industry. Isolation and screening of the industrially important strain from diverse ecosystem. Method of strain improvement, mutagenesis, strain breeding by protoplast fusion, sexual and para sexual recombination.**Fermentation technology**: principles of fermentation. Fermenter and bioreactors: monitoring and control of parameters, designing, operation and application. **Downstream processing**: filtration of fermentation broths recovery of biological products by distillation, superficial fluid extraction. Detection, analysis and quality control of fermentation products and raw materials.

Industrial productions - Industrial production of solvents-glycerol, acetone, and butanol. Microbial production of Interferons, Insulin, flavours and fragrances. Microbial production of polymers: Dextran and xanthan. Microbial transformations: Steroid biotransformation (DD+MM)
Production of Antiviral nucleoside, amino acids, lipid and fatty acids, amino acids (AKM)
Biology of Industrial Microorganisms: (*Saccharomyces, Aspergillus*, *Penicillium*, Spore forming bacteria etc.).Idea of Fermentation, Cell growth, Metabolism, Regulation of Metabolism, Substrate Assimilation / Product Secretion. Different fermentative system. Batch & Continuous processes, Fermentor Design, Surface & Submerged liquid substrate Fermentation. Solid substrate Fermentations, Fermentation Raw Materials, Biofertilizers and biopesticide formulation, Down Stream Processing, Bio Mass Production. Concepts of Immobilized Enzymes.

Practical: 30 MARKS

Industrial microbiology (MM+DD)

1.Isolation of amylase producing microorganisms from Soil
2. Isolation of cellulase and pectinase producing microorganisms from vegetable and fruit waste.
3. Isolation of lipase producing microorganisms from butter.
4.. To isolate antibiotic producing microorganisms form soil
5. To isolate *Penicillium* species producing penicillin.
6. Characterization of certain microbial contaminants in fruits and vegetables (AKM)

Food Microbiology Practicals (MM+DD)

1. Detection of adulterants in spices, pulses, sugar, tea.
2. Determination of quality of milk sample by methylene blue reductase test. Alkaline phosphatise test
3. Detection of number of bacteria in milk by SPC.
4. Detection of adulterants in milk and milk products
5. Isolation of microorganisms from spoiled food.
6. To demonstrate role of yeast in bread-making.
7. Contaminating microbes in food and their control

REFERENCE:

Prescott and Dunn (2005) Industrial Microbiology. CBS Publishers.
M. O. Moss and M. R. Adams (1995). Food Microbiology
William C. Frazier, Dennis C. Westhoff . Food Microbiology, 5th Edition Paperback 2017
Gary Higton, Michael J. Waites, John S. Rockey, Neil L. Morgan Industrial Microbiology: An introduction.
Peter F. Stanbury, Allan Whitaker 1984. Principles of Fermentation Technology.
Gerald Reed. Prescott and Dunn's Industrial Microbiology.

PAPER 8

THEORY 70 MARKS

Immunology and cancer biology

- **MODULE 1 (35 MARKS)**

Immune cells, MHC, VDJ recombination

Immune cells, PAMPS and PRRs (Toll like receptors); complement system.MHC/HLA; Antigen-processing and presentation.T-Cells: maturation, activation and differentiation, T-cell-Receptors B-cells: maturation, activation and differentiation.Antigens and antibodies.Organization and expression of Ig genes; VDJ recombination, Class switching.Cytokines; Hypersensitivity; Autoimmunity, Vaccination, Transplantation Immunology, immunodeficiencies (KS)

- **MODULE 2:**

Immunological techniques and cancer biology **(35 MARKS)**

Immunological techniques: Antibody generation, Antibody isolation and purification, Hybridoma technique, ELISA, ELISPOT, surface plasmon resonance, radioimmunoassay, Immunoblotting, Fluorescent Immunoassay (FIA) and Chemiluminescence Immunoassay (CLIA), Immunohistochemistry, Immunoprecipitation, Immune cell isolation, Lymphocyte Count from Blood (KS)

Cancer biology: Classification and Nomenclature, Signs and symptoms, Causes of cancer: Chemical carcinogens , Ionizing radiation , Infectious diseases, Hormonal imbalances, Immune system dysfunction, Heredity, Other causes. Pathophysiology of cancer: Epigenetics, Oncogenes, Tumor suppressor genes, cellsignalling and cancer. Cancer cell biology: Clonal evolution, Biological properties of cancer cell.Therapeutics: Antiangiogenesis, immunotherapy,

PRACTICAL: 30 MARKS

ELISA, Western blot, Separation of IgG by column chromatography, Lymphocyte Count from Blood,

REFERENCE:

1. Kuby Immunology, Kindt, Goldsby, Osborne.
2. Roitt's Essential Immunology (Essentials) by Seamus J. Martin (Author), Dennis R. Burton (Author), Ivan M. Roitt (Author), Peter J. Delves
3. The biology of Cancer. Robert A Weinberg.
4. Molecular Biology of Cancer, Mechanisms Targets And Therapeutics Edition 2006 by Pecorino L, Oxford University Press