Master's Degree course in Microbiology

VBS Purvanchal University, Jaunpur

Scheme of Examination

SEMESTER I

Paper I Basic Microbiology		50
Paper II Elementary Biochemistry		50
Paper III Cell Biology and Virology		50
Paper IV Molecular biology and Microbial Genetics		50
Practical	80+20 (sessional)	100

SEMESTER II

Paper V Instrumentation and Analytical Techniques		50
Paper VI Environmental Microbiology		50
Paper VII Immunology		50
Paper VIII Recombinant DNA Technology		50
Practical	80+20 (sessional)	100

SEMESTER III

Paper IX Biostatistics and Bioinformatics		50
Paper X Microbial Physiology and Metabolism		50
Paper XI Industrial Microbiology		50
Paper XII Bioprocess Technology		50
Practical	80+20 (sessional)	100

SEMESTER IV

Paper XIII Clinical Microbiology	75
Paper XIV Agriculture and Food Microbiology	75
Project /Dissertation report presentation	150

SEMESTER I
Paper – I Basic Microbiology

UNIT I
Introduction, history, development; scope and relation with other sciences. Nature of microbial world: General features of eukaryotic and prokaryotic cells. Cell wall, cell membrane, capsules, pilli, flagella, tactic movement, storage granules, mesosomes, nucleoid, biosynthesis of cell wall etc.

UNIT II
Habitat, structure, reproduction and classification and phylogeny of bacteria, actinomycetes, cyanobacteria, mollicutes, rickettsia, chalamydiae, fungi and slime molds. Modern approaches of bacterial taxonomy (polyphasic approach of taxonomy: numerical, chemotaxonomy, biolog, fatty acid methyl ester analysis / 16s RNA analysis etc.).

UNIT III
Sterilization, disinfection and sanitization. Media preparation, sterilization methods: isolation and cultivation of aerobic and anaerobic bacteria and fungi, types of media, preservation and maintenance of Microorganisms.

UNIT IV
Nutritional requirement of microorganisms, definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous growth. Factors affecting growth (temperature, acidity, alkalinity, water availability and oxygen), reproduction.

UNIT V
Introduction to microbial metabolism, brief account of pathways like glycolysis, kreb's cycle, PP pathway, ED pathway, β ketoadipate.Extremophilic microorganisms; strategies of survival and application. Microorganisms as a geobiological agents.

Practicals
1. Washing and sterilization of labware
2. Acquaintance with microbiological laboratory and techniques
3. Preparation of media and reagents (selective, differential, enriched, general etc.)
4. Isolation of pure culture of microorganisms – Plating, Streaking and spreading
5. Staining techniques of bacterial strains: simple, differential, negative, specialized
6. Measurement of growth and preparation of growth curve
7. Effect of temperature, pH, salt concentration, antibiotics on growth.
8. Calculation of generation time and specific growth rate.
9. Determination of MIC for different antibiotics.
10. Isolation of anaerobic bacteria.

Books recommended

1. Prescott, Harley and Klein's Microbiology, (7th Edition, 2008) – Willey, Sherwood andWoolverton. McgrawHill, International Ed.
2. Microbiology – Principles and Exploration (5th Edition, 2002), J.G. Black. John Wiley and Sons
3. Microbiology: An Introduction by Gerard J. Tortora, VthEds
4. Fundamentals of microbiology: Jeffrey: C. Pommerville 7th Eds
5. Microbiology: Michael J.Pelczar, JR VthEds, Tata Mc. Graw- Hill Publishing Company limited.

Paper - II Elementary Biochemistry

UNIT I

Proteins: Amino acids; classification and general properties, peptide synthesis, chemical/synthesis. Primary (peptide conformation, N and C terminal, peptide cleavage), secondary (helix, sheet, random coil, Ramachandran plot), tertiary and quaternary structures of proteins, denaturation.andrenaturation. Protein folding.Oxygen haemoglobin interaction.

UNIT II

Lipids: Definition, classification, structure, properties and function of fatty acids, essential fatty acids, phospholipids, sphingolipids, cerebroside, steroids, bile acids, prostaglandins, waxes, terpenes, lipoamino acids, lipoproteins, proteolipids, lipopolysaccharides.

UNIT III

Carbohydrates: Classification, structure, general properties and functions of mono-, oligo-, (Disacharides), and polysaccharides. Complex carbohydrates, mucopolysaccharides, amino sugars, bacterial cell wall sugars, proteoglycans, glycoproteins, blood sugar compounds.

UNIT IV

Nucleic Acids: Historical perspectives; nucleic acids as genetic information carriers, experimental evidences, e.g., genetic transformation, Hershey-Chase experiments. Structure and function of nucleotides.Denaturation of DNA.Mitochondrial and chloroplast DNA. RNA and 3D structure of tRNA Helix transition. Linking number, twist and writhe; A, B and Z DNA.

UNIT V

Bioenergetics – Concept of free energy and standard free energy. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials and free energy change Porphyrins and cytochromes: Classification, structure and function. Enzymes: coenzymes, cofactors and prosthetics groups. Classification of enzymes, kinetics, mechanism of action; competitive, uncompetitive andnoncompetitive inhibition, allosteric and regulatory enzymes.Porphyrins and Cytochromes - Classification, structure and function.

Practicals

1. Quantitative estimation carbohydrate (anthrone/ phenol-H_2SO_4/Dinitrosalisylic acid method).
2. Quantitative estimation of proteins by biuret/ Lowry method.
3. Saponification and acid value of fats
4. Estimation of DNA by diphenylamine method
5. Estimation of RNA by orcinol method
6. Determination of pKa value of amino acids

Books recommended

1. Principles of Biochemistry (5th Edition) – Lehninger, Nelson and Cox. Pub Macmillan
2. Harper's Illustrated Biochemistry, (28th Edition) – R.K. Murray, D.K. Garner, P.A. Mayers and V.W. Rockwell, Pub: McGraw Hill International Edition.
3. Biochemistry (3rd Edition) – G. Zubay., Pub: Wm. C. Brown Pub.
4. Biochemistry (5th Edition) – LubertStryer. Pub: W.H. Freeman and Com., NY.
5. Biochemistry – (2^{nd} edition) D. Voet and J.G. VoetPub: John Willy and Son
6. Practical Biochemistry (3rd Edition) – David Plummer. Pub: Tata McGraw Hill
7. Practical Biochemistry (5th Edition) – K. Wilson and J. Walker. Pub: Cambridge Univ. Press, (U.K.)

Paper - III Cell Biology and Virology

UNIT I

Diversity of cell size and shape, cell theory. Cellular organelles: Cell wall plasma membrane, nucleus their structural organization, mitochondria, chloroplast their structure and brief description. Endoplasmic reticulum and protein segregation, centrosome, lysosome.peroxisome, glyoxisome and their role in cellular metabolism.

UNIT II

Plant and animal cells: Cell division and cell cycle control, cell differentiation. Cell interaction: Cell-cell adhesion, cytoskeleton (microfilament, microtubule and intermediate filament).

UNIT III

Programmed cell death: Apoptosis - role of caspase and mitochondria mediated pathway of apoptosis.Organization of viral, bacterial and eukaryotic genomes, satellite DNA..

UNIT IV

Cell signalling: Hormones and their receptors, cell surface receptor, signalling through G protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways. Molecular Oncology: Carcinogenesis, characteristics of cancer cells, agents promoting carcinogenesis.

UNIT V

Viruses:General properties, bacterial, plant and animal viruses-their discovery, life Cycle and classification of DNA and RNA viruses Example of Herpes, Pox, Adenoviruses, Retroviruses: General feature of prions, viroids, and virusoids, bacteriophage and phage therapy.

Practicals

1. Microscopic measurements (micrometry)
2. Nucleus staining of blood cells by haematoxylin.
3. Isolation of nucleus, mitochondria, chloroplast and other cell organelles.
4. Karyotyping.
5. To study mitosis in onion root tip and meiosis in flower bud.
6. Isolation of bacteriophages

Books recommended

1. Molecular biology of the cell, (4th Edition) – Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter, Pub: G.S. Garland science Taylor and Francis Group New York – NY 10001-
2. Molecular Cell Biology, (5th Edition) H. Lodish, A. Berk P. Matsudaira Chris A.Kaiser, M.Krieger. M. P. Scott, L. Zipursky, J. Darnell. Pub: W.H. Freeman and Com., NY.
3. Cell and Molecular Biology: Concepts and Experiments:Gerald Karp, VIthEds

Paper- IV Molecular Biology and Microbial Genetics

UNIT I

Recapitulation of Mendel's law of inheritance. Linkage, crossing over and gene mapping through traditional methods. Mutation – Types, mechanisms and their mapping. Types of mutagens and their screening through Ames test.

UNIT II

Nucleic acids as genetic material,C value paradox. Cot analysis, repetitive DNA.classes of DNA sequences, Genetic code: Deciphering genetic code, degeneracy, unusual codons in mitochondriaand prokaryotes. DNA damage and repair.Concept of gene fine structure.

UNIT III

Basic concept andmolecular mechanism of genetic recombination in prokaryotes, Transduction.-discovery, generalized and specialized recombination, regulation of lytic and lysogenic cycle; Conjugation: discovery, mechanism of formation of Hfr and F' and their role in recombination, concept of transferosomes, bacterial gene mapping; Transformation: discovery, mechanism of transformation in Gram positive and Gram negative bacteria, natural and artificial transformation.Fungal genetics.

UNIT IV

Replication of genetic material in prokaryotes and eukaryotes.Mechanism of transcription in prokaryotes and eukaryotes.transcription factors. RNApolymerases, initiation, elongation and termination.Translation: Initiation, elongation and termination. Post transcriptional modification and RNA processing : mRNA, tRNA and rRNA.

UNIT V

Regulation of gene expression:Positive and negative control, operon concepts – *lac*- and *trp*-operon, attenuation. An overview of regulation of gene expression in prokaryotes and eukaryotes.*cis* acting sites and *trans* acting molecules. Transposable genetic elements.

Practicals

1. UV sensitivity in bacteria and isolation of mutants.
2. Ames test
3. Isolation of Auxotrophs of bacteria.
4. Diauxic growth curve on lactose/glucose as carbon source in bacteria.
5. Numerical problems on classical genetics.

Books recommended

1. Genetics: Analysis and Principles by Robert J. Brooker, IIIrdEds
2. Principles of Genetics by Eldon J. Gardner, 12thEds
3. Modern Genetic Analysis: Integrating Genes and Genomes by Anthony J.F. Griffiths 7th
4. Gene by Benjamin Lewin, IXthEds,Oxford Univ. Press, U.K..
5. Molecular Biology of gene by Watson, 12th Eds
6. Genetics Strickberger 13thEds
7. Cell and Molecular Biology (8th Edition) – DeRobertis and DeRoberties, B.I. Pub. Publishers Pvt Ltd. N. Delhi

SEMESTERII

Paper V Instrumentation and Analytical Techniques

UNIT I

Chromatography: Principles and types; Adsorption, partition, gel filtration, ion exchange, affinity, paper, thin layer, gas chromatography, HPLC. Electrochemistry – pH and buffers.

UNIT II

Microscopy: Principles and types; Light, phase contrast, fluorescence, electron (SEM, TEM) microscopy, Confocal microscopy. Centrifugation: Introduction and principles of laboratory centrifuges, differential centrifugation, ultracentrifugation, and density gradient centrifugation.

UNIT III

Electrophoresis: Principles, PAGE, agarose gel electrophoresis, isoelectric focusing, isotachophoresis, two dimensional electrophoresis, pulse field electrophoresis. Photometry: Theory, instrumentation and applications of visible photometry, spectophotometry (UV, visible, IR) and fluorimetry. Bioanalyzer.

UNIT IV

Spectroscopy: Theory, Beer's Lambert's law, instrumentation and applications of atomic absorption and emission spectroscopy, nuclear magnetic resonance spectroscopy, electron paramagnetic resonance spectroscopy, electron spin resonance spectroscopy, mass spectroscopy, X-ray diffraction and Raman spectroscopy; atomic absorption and plasma emission spectroscopy. Biosensors: basic techniques, enzyme electrode, organic salt electrodes, immunoelectrodes, microbial biosensors.

UNIT V

Tracer techniques: autoradiography, detection and measurement of isotopes; cerenbow counting, liquid scintillation counter. Plasma Emission Spectroscopy: optical methods for determination of molecular structure; Absorption of polarized light, optical rotatory dispersion, hypochromism, circular dichroism and infrared dichroism in relation to composition and structure of biomolecules.

Practicals

1. Paper chromatography – Separation of pigments, amino acids
2. Separation of amino acids by Thin layer chromatography
3. Column chromatography
4. Horizontal and vertical gel electrophoresis
5. Paper electrophoresis

Books recommended

1. Physical Biochemistry (2nd Edition) D. FriefelderPub: W.H. Freeman and Com
2. Practical Biochemistry (5th Edition) – K. Wilson and J. Walker. Pub: Cambridge Univ. Press, (U.K.)
3. Molecular Cloning : a laboratory manual: Sambrook and Russel (Vol I, II, III)
4. Practical Biochemistry by Plummer

Paper -VI Environmental Microbiology

UNIT I:
Water, soil and air as a component of environment. Environment:Physico-chemical and biological characteristics and analysis Pollutants - Nature, origin, source, monitoring and their impacts. Water pollution - Industrial effluents, domestic wastes and agrochemicals.Soil pollution - Agrochemical, industrial etc.Air pollution.

UNIT II:
Toxicology of common Pollutants - carcinogens and mutagens. Radiation as an environmental pollutant, hazards, monitoring and disposal. Xenobiotic degradation.

UNIT III
Types of solid waste, transportation, recycling, reuse and disposal for waste management. Waste as a source of biofuels and biomolecules. Waste water (sewage) treatment-physical, chemical and biological treatment processes. Microbiology of wastewater treatment: Aerobic process-activated sludge, oxidation ditched trickling filter. "Towers.' rotating discs, rotating drums, oxidation ponds. Anaerobic process, anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors.

UNIT IV
Isolation and identification of different types of microorganisms in the environment. Role of microorganisms in domestic and industrial sewage. Treatment of waste waters of dairy, distillery, tannery and sugar industry and bioleaching.

UNIT V
Interaction among microbial population, Quram sensing; types & significance.Microorganisms and biogeochemical cycles.Water and food bacteriology.

Practicals
1. Analysis of water quality: DO, BOD, alkalinity, free CO_2, free chloride, TS, TSS, TDS, nitrate, phosphate
2.Determintation of most probable number (MPN) for coliform bacteria
3. Milk quality test (methylene blue reduction test,
4. Ames test
5. Isolation of bacterial strains from different soil samples

Books recommended
1.Introduction of Soil Microorganisms by Martin Alexander, Krieger pub Co.
2. Microbial Ecology - Fundamentals and application by Atlas and Bartha, Edition 4th , Benjamin Cummings.
3. Principles of Microbial Ecology by Brock, TD, Edition 3rd , Prentice-Hall.
4. Microbial Ecology by Campbell, RE, Edition 2nd, Blackwell Science.
5. Environmental Microbiology by Maier, RM, Pepper, IL, gerba, CP, Edition 2nd, Academic Press.
6. Microbiology of Extremes Environments by Edward, C, McGraw Hill, New York.

Paper VII Immunology

UNIT I

Basic concepts of Immunology – (a) Innate and acquired Immunity (b) concept of humoral and cell mediated Immunity.Organization and structure of lymphoid organs.Cell and the immune system: Memory, specificity, diversity, self Vsnonself discrimination, B lymphocytes, T lymphocytes, Macrophages, Dendritic cells, NK cells, Eosinophils, Basophils, Neutrophils, Mast cells.Immunization – Active and passive.Vaccines; types and importance.

UNIT II

Nature of antigen and antibody: Antigen Vs Immunogen, Superantigen, heptanes, types and structure of antibody – (i) constant and variable region Fab and Fc (ii) Isotype and idiotype.Antigen antibody interactions: detection and estimation of antigen and antibody, primary and secondary reactions, antibody affinity and acidity, equilibrium dialysis, precipitation and agglutination reactions, complement fixation test, RIA, ELISA, immunoblotting, immunofluorescence, biotin-avidin assay.

UNIT III

Central role of MHC genes and products in immune response.T cell recognition of antigen and MHC products, structure of MHC gene complex, polymorphism of MHC genes and products.Activation of T and B cells by antigen: Antigen processing, antigen presentation on T cells, products and factors released by T cell activation: interleukins, interferons. Cell mediated cytotoxicity, mechanism of T cell and NK cell mediated lysis, ADCC, macrophage cytotoxicity.

UNIT IV

Generation of diversity in immune response: clonal selection theory, concept of antigen specific receptor, BCR, TCR, the genes encoding antigen: specific receptors on T and B lymphocytes, genetic rearrangements, class switch, comparison of receptor on B and T lymphocytes, mechanism of immune response and generation of immunological diversity. Complement system: classical and alternative pathways.Hypersensitivity type I, II, III, and IV type.Types of graft, barriers of transplantation, mechanism of rejection of allograft, prevention of graft rejection.

UNIT V

Monoclonal antibody: Production by hybridoma technology, application. Immunodeficiency: T cell, B cell, combined B and T cell deficiencies, defect in phagocytes and complement components, secondary immunodeficiency, AIDS, Autoimmunity. Immunization: active and passive, vaccines- types and importance.

Practicals

1. Double immune diffusion
2. Determination of Blood group
3. Isolation of Macrophages
4. Determination of hypersensitivity
5. Immunobloting
6. Raising of Ab in mice/rabbit.
7. ELISA

Books recommended

1. Immunology:Kubey, VIthEds
2. Fundamental Immunology by William E Paul, VthEds
3. Immunobiology by C. Janeway, VIIthEds
4. Immunology by Riott and Riott

Paper VIII Recombinant DNA Technology

UNIT I

Host:Vector systems, cloning vectors (plasmids, phages, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes), shuttle vectors, expression vectors, screening and selection methods for recombinants. HACS. Enzymes used for manipulating DNA (restriction endonucleases, methylases, polymerases, ligases, kinases and nucleases).

UNIT II

Preparation of competent cells and their transformation.Isolation of DNA (plasmid, cosmid, phage and genomic DNA) and RNA from prokaryotes and eukaryotes.Construction of genomic and cDNA library.

UNIT III

Screening and characterization of cloned DNA, restriction mapping and RFLP analysis. Southern, Eastern and Northern Hybridization probe preparation, heterologous and homologous Expression of cloned genes in cultured cells, synthetic oligonucleotides probes. *In situ* hybridization.Antibodies in screening of library.

UNIT IV

PCR and its application. Site directed mutagenesis. DNA:protein interaction: gel mobility shift assay, DNA footprinting, protein:protein interaction. Principles and method of genetic engineering and gene targeting.Real time PCR and SNPs.

UNIT V

DNA sequencing: Sanger's Method, Automated sequencing. Application of recombinant DNA technology in agriculture, health and industry. RNA Interference. Brief account of proteomics, genomics, transcriptonomics and metabolomics.

Practicals

1. Isolation and quantification of plasmid DNA, genomic DNA and RNA of *E. Coli*
2. Competent cells preparation of *E. coli*
3. Transformation and selection of transformant of *E. coli* cells using antibiotics and X gal selection
4. Unit determination of restriction enzyme activity
5. Restriction digestion of DNA and gene cloning
6. Demonstration of PCR

Books recommended

1. Gene Cloning and DNA Analysis: An Introduction: TA Brown, VthEds
2. Human Molecular Genetics:PA Reads, III Eds
3. Gene Cloning and Manipulation by Christopher Howe, II Eds
4. Principle of gene cloning, Old and primrose VthEds
5. Molecular Cloning: A laboratory manual manual Maniatis, E.F. Fritsehand J. Sambrook (CSHl.
6. DNA Cloning: A practical approach - D.M. Glover URL Press)
7. DNA Science: A first course in Recombinant DNA Technology - David A. Michlos and Creg A. Freyer

SEMESTER III

Paper IX Biostatistics and Bioinformatics

Section A

UNIT I

Scope of biostatistics, variables in biology.Collection, classification, tabulation and diagrammatic presentation of statistical data.

UNIT II

Concepts of statistical population and samples.Measures of Central tendencies and Dispersion.

UNIT III

Sample size calculation. Simple measure of Skewness and Kurtosis Probability: definition, simple theorems of probability and simple application of probability.Binomial and Poisson distributions.

UNIT IV

Correlation, correlation coefficient, standard error of estimate and regression. Linear regressions, least square method of fitting.

UNITV

Basic idea of significance, testing level of significance, random variations. Statistical analysis test e.g Chi square ($\chi 2$) test,'t' test etc .

Section B

UNIT I

Introductory concepts of computer languages: machine, assembly, high level and 4 GL.

UNIT II

Elementary ideas of applications of common spreadsheet, word processing, graphics, DOS and Windows based software packages, MS office.

UNIT III

Introduction and scope of bioinformatics. Molecular and Genomic databases (NCBI).

UNITIV

Analysis of sequence data (BLAST, Protein database), prediction of protein.

UNIT V

Product of ORF, its structure and function. Preparation of dendrogram.

Practicals

1. Biostatistics: Diagrams and graphs; measure of central tendencies and dispersion , measure of skewness and kurtosis, Probability, Normal, Binomial and poisson distribution, correlation and regression, Normal deviates and students "T" test; Chi Square test, Analysis of variance, Correlation analysis, Regression analysis.
2. Analysis of sequence data and searching of research papers from various national and international journals
3. Retreival of gene and protein sequences from data bank
4. Sequence comparisons and alignment (8P)
5. Visualisation and other utilities (PDB viewer)

Books recommended

1. Fundamentals of Biostatistics: Bernard Rosner III Eds
2. Principles of Biostatistics –Marcello Pagano II Eds
3. Basic Biostatistics: B. Burt Gerstman II Eds
4. Bioinformatics: A practical guide to the analysis of genes and proteins - Ed. Andreas, D. Baxevanis. E.F. Foncis- John Wiley and Sons.
5. Biostatics - Garret
6. Statistics Scluium's series publication,
7. Statistical analysis - A Computer oriented approach II nd Ed. Academic Press NY.
8. Fundamentals of statistics - D.N. Elthance
9. Statistical methods for research workers - Central publisher Ludhiana

Paper-- X Microbial Physiology and Metabolism

UNIT I

Respiration: Aerobic and anaerobic carbohydrate metabolism (EMP pathway). Alternate route of glucose metabolism, pentose phosphate pathway, Kreb's cycle, glyoxylate shunt, oxidation of pyruvate as central hub to various metabolic pathways, Metabolism of volutin (polyphosphates), glycogen, poly β-hydroxybutyrate.

UNIT II

Respiratory Electron Transport - Components of electron transport chain, energy transduction and proton motive force, chemiosmotic theory of ATP generation, mechanism of ATP generation.Lipid metabolism- α and β oxidation, protein metabolism, urea cycle.

UNIT III

Photosynthesis in microorganisms (green sulphur and purple sulphur bacteria), structural and functional properties of pigment, oxygenic and anoxygenic photosynthesis, photosystems, photodynamic death and photophosphorylation. cyanobacterial photosynthesis, photorespiration Chemolithotrophy, hydrogen-, iron- and sulfur, bacteria, methanogens and methylotrophs.

UNIT IV

Biochemistry of nitrogenase complex, nitrogenase types and function ***nif*** gene and genetic regulation of nitrogenase, symbiotic nitrogen fixation, regulation of nitrogenase by oxygen and combined N-sources, protection of nitrogenase against oxygen, nitrate reduction (assimilatory and dissimilatory) and sulfate reduction, methanogenesis and acetogenesis. Hydrocarbon transformation, storage granules. Endospore- process of sporulation, generation and regulation.

UNITV

Bacterial transport system: Donnan equilibrium, thermodynamics of various transport systems, osmosis, plasmolysis, osmotic pressure of electrolyte and non-electrolyte transport protein PEP-PTS system in relation to catabolite repression.ABC transporter.

Practicals

1. Biochemical tests for characterization of microbes (based on metabolic properties:
   a. carbohydrate fermentation
   b. H_2S production
   c. Nitrate reduction
   d. urease activity
   e. IMViC test
   f. Gelatin liquefaction
   g. starch hydrolysis
   h. glycine decarboxylation
   i. catalase oxidase peroxidase test
2. Staining of polyphosphate bodies, polyhydroxybutyrate and endospore

Books recommended

1. Microbial Physiology, Moat, AG, Foster, JW and Spector, MP, Edition 4th, John Willey Publication.
2. Biology of microorganisms by Madigan, MT, Martinko, JM, stahl, DA and clark, DP, Edition 13th Benjamin Cummings.
3. Advances in Microbial Physiology by Rabert Poole, RK., Volume 53 Elsevier Science & Technology
4. Microbial Physiology and Metabolism by Caldwell, DR, Edition 2nd, Star Pub Co.

Paper-XI Industrial Microbiology

UNIT I

Introduction, scope and relation with other sciences. Screening for new metabolites - primary and secondary metabolites. Strain development through selection, mutation, recombination and other genetic and biochemical methods.

UNIT II

Substrates for fermentations - types and availability. Fermentation different types and systems. Design and working of a typical bioreactor. Introduction to immobilization technology for enzymes and cells.

UNIT III

Production of alcohol (ethanol), Organic acid (citric acid. lactic acid), amino acid (lysine, glutamic acid), nucleotides and related compounds. Production of enzymes (protease, amylase, lipase). Production of microbial food, single cell proteins and mushroom.

UNIT IV

Antibiotics (streptomycin, tetracycline, penicillin, ampicillin), hormones, vitamins, steroids, alkaloids etc. Synthesis of commercial products by recombinant microorganisms: restriction endonucleases, biopolymers, human insulin, growth hormones, interferon and vaccines.

UNIT V

Microorganisms in Biotransformation of antibiotics and steroids; microorganism as biofertilizers. biopesticides, biosensors, biochips etc.

Practicals

1. Isolation of protease, amylase and lipase producing strains and estimation of these enzymes
2. Mushroom production
3. Efficiency assessment of PGPR (Production of HCN, ammonia, Siderophore, phosphate solubilization antibiotic, IAA and antifungal activity)
4. Cell and enzyme immobilization.
5. Production of alcohol from molasses/cane sugar.
6. Production of vinegar.
7. Production of citric acid.
8. Isolation of cellulose producing strain.
9. Isolation of Rhizobia from root nodule.

Books recommended

1. Prescott and Dunn's Industrial Microbiology by Reed, G, CBS Publishers & Distributors.
2. Biotechnology - A text book of Industrial Microbiology WulfCrueger&AnnelieseCrueger
3. Microbial biotechnology: Fundamentals of Applied Microbiology by Glazer, AN, and Nikaido, H, edition 2nd, Cambridge University Press.
4. General Microbiology by StainerRY, Adelberg, EA, John, LI, Edition, 1st, Macmillan Pub.
5. Flow through (bio) chemical sensors byValearccl M & de Castrol
6. Industrial Microbiology: An introduction by Waites, MJ, Morgan, NL, Rockey, JS,Higton, G, Edition .1st, Wiley-Blackwell. 2001
7. Manual of Industrial Microbial & Biotechnology, by Baltz, RH, Davies, JE, Demain, AL, Demain, Edition 3rd, American Society of Microbiology.

Paper- XII Bioprocess Technology

UNIT I

Introduction to the bioprocess technology. Microbial growth kinetics: batch culture, continuous culture and fed batch culture.

UNIT II

Transport phenomenon in bioprocess: Introduction, oxygen requirement in industrial fermentation, oxygen supply and oxygen transfer rate, factors affecting oxygen transfer rate, determination of Kla values.

UNIT III

Non-Newtonian fluids, heat transfer and heat transfer correlation, and mass and energy balance.

UNIT IV

Introduction to bioreactor: Ideal bioreactor, Reactor with non-ideal mixing, Sterilization reactors, Multiphase bioreactors, animal and plant cell reactor technology.

UNIT V

Instrumentation and control:

A. Methods of measuring process variability
   a. Temperature
   b. Flow
   c. Pressure
   d. DO and free CO_2
   e. pH and other chemical factors

B. Control systems
   a. Manual
   b. Automatic
   c. Computers and interface

Practicals

1. Measurement of *K*s value
2. Determination of specific growth rate and generation time
3. Estimation of KLa value by sufite oxidation method
4. Demonstration of Fermentation technique using bioreactor.
5. Production of citric acid, alcohol, organic acid, solvent in CSTR packed bed and column reactor.

Books recommended

1. Fundamentals of Biochemical engineering By Bailly and Ollis Mac Graw Hill publication
2. Bioprocess engineering by Doran, PM, Academic Press.
3. Principles of fermentation Technology by Stanbury, PF, Whitaker, A, Hall, SJ,Society for General Microbiology, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG, UK
4. Bioprocess technology by S.N Mukhopadhyay Viva publication
5. Manual of Industrial Microbial & Biotechnology, by Baltz, RH, Davies, JE, Demain, AL, Demain, Edition 3rd, American Society of Microbiology.

SEMESTER: IV

XIII Clinical Microbiology

UNIT I

History of medically important microorganisms; normal microflora of Human body. Collection, transportation and examination of pathologic specimens.Isolation and identification of pathogenic organisms.

UNIT II

Pathogenicity: Virulence factors, spreading and establishment of pathogens, bacterial toxins-their types, mycotoxins, involvement of extra-genetic elements. Epidemiology of infection diseases.

UNIT III

Brief account of bacterial diseases spread through air (diptheria, tuberculosis and pertusis), food and water (typhoid, cholera and dysentery) soil (anthrax, tetanus, and gas gangrene) and contact (leprosy, conjunctivitis and venereal diseases). Bacterial zoonoses (brucellosis, bubonic plague and salmonellosis) and protozoal diseases (malaria, filarial and kalazar). Etiology, epidemiology, pathogenesis, symptomology, pathology, disease diagnosis and treatment fungal diseases: Candidiasis, histoplasmosis, aspergillosis, cryptooccosis and dermatomycosis.

UNIT IV

General characteristics of common viral diseases like influenza (pneumotropic): herpes simplex, small pox, measles and rubella (dermotropic); dengue fever, hepatitis and AIDS (viscerotropic): rabies, poliomyelitis and slow virus disease (neurotropic). encephalitis and yellow fever viral zoonoses).

UNIT V

Principles of chemotherapy, role of antimicrobial agents and mechanisms of their action with special reference to antibiotics.Molecular basis of drug resistance in bacteria, and drug sensitivity test. Nosocomial and emerging microbial infection diseases. Biosafety practices in biological sciences and disposal of biomedical waste, Bio-terrorism.

Books recommended

1.Medical Microbiology by Murray, PR, Rosenthal, KS, Kobayashi, GS & Pfaller, MA (ed III) Mosby Inc.

2.Essentials of Medical Microbiology By Volk WA, Gebhardt, BM, Hammarskjold, ML &Kadner RJ (Ed V) Lipincott-Raven Publisher, Philadelphia

3.Jawetz, Melnick & Adelberg's medical microbiology by Brooks, GF, Carroll, KC, Butel,JS, Morse,SA, Edition 24th, McGraw-Hill Medical,

4. Medical Microbiology by Cruikshank, Edition 12th, Churchill LivingstonePub.

Paper - XIV Agriculture and Food Microbiology

UNIT I

Microorganisms in soil: Rhizosphere, phyllosphere and PGPR. Plant microbe relationships: Association and pathogenicity, symptoms of plant diseases caused by fungi, bacteria and viruses, viability and variability in plant pathogens

UNIT II

Principle and methods of control of common fungal diseases (wilt, mildew, rust): bacterial diseases (canker, blight): viral (mosaics and curls). Control of insect pests through biological methods bacteria *(Bacillus thuringiensis*, *Pseudomonas* spp*).* Virus *(nuclear polyhedrosis virus, cytoplasmic polyhedral virus) and* fungi (*Metarrhinium anisoplial, Beauveria bassiana, Verticellum lecani, Hersutells thomsoni*)

UNIT III

Mycorrhizal association: Their types and role in plant nutrition. Biofertilizer: Production and method of application.

UNIT IV

Food as a substrate for microorganisms, their types: food borne microorganisms. Microbial spoilage of food and factors affecting them: Spoilage of various kinds of foods: fish. meat, poultry, sea foods, bread and dairy products). Food poisoning: Botulinism and staphylococcal toxicity. Food adulteration and prevailing food standards in India. Indicator Microorganisms: As an indicator of good quality.

UNIT V

Food preservation, Food adulteration and prevailing food standards in India.Source of microorganisms in milk and their types.Microbiological examination of milk (standard plate count, direct microscopic count, reductase and phosphatase test).Dehydration and pasteurization of milk.Common fermented foods and food produced by microbiological. Curd, yoghurt, sauerkraut, fermented/condensed milk, pickles, sauce, bear, wine, vinegar, cheese, bread and kefir.

Books recommended

1. Food Microbiology Fundamentals and Frontiers By Doyle, MP, Beuchat, LR & Montville, TJ ASM Press
2.Food Microbiology by Adams AR, & Moss MO Third edition, Royal Society of Chemistry publishing .
3.Food Microbiology ByFrazier, WC, and Westhoff, DC. Fourth edition, MacGraw Hills publication
4.Plant Pathology by Agrios GN. Fifth edition, Elsevier Academic press.
5. Agriculture Microbiology by Rangaswami, G, and Bagyaraj, DJ, edition 2nd, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Advances in Agriculture Microbiology by SubbaRao, NS, Oxford & IBH Pub.
7. Molecular plant pathology by M. Dickinson, Bios Scientific Publishers , New York.

Project Dissertation Report/ (3-4 months)