

Semester- V
Course MI-301
Molecular Genetics of Prokaryotes

Unit I. Fundamentals

1. Nature of Genetic material (3 hr)
 - A. Understanding of terms: Gene, allele, genotype, phenotype, intron, exon, cistron, recon, muton, plasmid, chromosome, genome, zygote, merozygote
 - B. Experimental proof for DNA as genetic material: Work of Griffith; Avery, McCarty and MacLeod; Hershey and Chase
2. Gene structure and function (2 hr)
 - A. Chemistry of DNA, Watson and Cricks model of DNA structure
 - B. Typical gene structure, functions of gene
3. DNA replication (5 hr)
 - A. Semi conservative nature, Meselson and Stahl's experiment
 - B. Molecular mechanism: Strand separation, formation of leading and lagging strand, formation of Okazaki fragments and their removal, proof reading
 - C. Post-replicative modifications and their significance

Unit II. Gene Expression and its Regulation

1. Transcription (2 hr)
 - i. Initiation, role of enzyme, sigma factor, promoter, operator
 - ii. Elongation
 - iii. Termination: Rho dependent and Rho independent
2. Genetic code: Triplet nature, polarity, degeneracy, near universality and Wobble phenomenon (2 hr)
3. Translation (3 hr)
 - i. Initiation, 70 S initiation complex,
 - ii. Elongation: recognition, peptidyl transfer, translocation
 - iii. Termination
 - iv. Fate of ribosomes, polysome system, polycistronic RNA
4. Regulation of gene expression (3 hr)
 - i. Negative inducible control - *lac* operon
 - ii. Negative repressible control - *trp* operon
 - iii. Positive regulation - *lac* operon

Unit III. DNA Damages and their Repair

1. Introduction (2 hr)
 - A. Spontaneous and induced mutations, proof for spontaneity of mutation by replica plate method
 - B. Effect at DNA level, transition, transversion, insertion, deletion, development of A-P Sites
2. Molecular basis of mutation (3 hr)
 - A. Chemical mutagenesis: 5-bromouracil, nitrous acid and acradine orange
 - B. Physical mutagenesis: Ultraviolet radiations
 - C. Biological Mutagenesis: Phage Mu,
3. Consequences of mutation (3 hr)
 - A. Forward - silent, missense, nonsense, frame shift
 - B. Reverse – true reversion, suppressions (intragenic and extragenic only)
 - C. Classes of bacteria mutants; Nutritional, resistant, morphological and conditional mutants
4. Repair mechanisms (2 hr)
 - A. Direct repair: Photoreactivation, removal of A-P sites
 - B. Indirect repair: Excision repair, mismatch repair
 - C. SOS regulatory system

Unit IV. Gene Transfer among Bacteria

1. Fundamentals: Horizontal and vertical gene transfer, merozygotic system (1 hr)
2. Transformation: Competence, DNA uptake in Gram positive and Gram negative bacteria, transfection (2 hr)
3. Transduction: Generalized and restricted transduction (2 hr)
3. Conjugation: Role of sex factor, transfer of genes during $F^+ \times F^-$, Hfr $\times F^-$ and sexduction (2 hr)
4. Bacterial plasmids and transposable elements (3 hr)
 - A. General properties, compatibility groups, maintenance of plasmids
 - B. Types of plasmids
 - C. Transposable elements: their nature, insertion sequences (*IS*) and *Tn* elements

Text Books:

1. Prescott L, Harley J P, and Klein D A, (2008). **Microbiology**, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA.
2. Atlas R M, (1997), **Principles of Microbiology**. 2nd edn. Wm. C. Brown Pub., Iowa, USA.

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Semester- V
Course MI-302
Bacterial Metabolism

- Unit I. Enzymes and Energy**
1. Enzyme kinetics (2 hr)
 - A. Michaelis-Menten equation,
 - B. Lineweaver-Burk plot & its significance
 2. Metabolic regulation (3 hr)
 - A. Significance of metabolic regulation
 - B. Types of regulatory mechanisms: Feedback inhibition, energy linked control, precursor activation, zymogen activation, covalent modification and allosterism
 3. Energy: its generation & conservation (5 hr)
 - A. Laws of thermodynamics, free energy change, redox potential, exothermic and endothermic reactions
 - B. Energy rich compounds and their role
 - C. Modes of ATP generation
 - i. Substrate level phosphorylation
 - ii. Role of electron transport chain: Components of electron transport chain in bacteria
 - iii. Generation of proton motive force and its conversion in to ATP by role of ATP phosphohydrolase, chemiosmosis, inhibitors and uncouplers
 - iv. Anaerobic respiration and fermentation
- Unit II. Chemoheterotrophic Metabolism**
1. Utilizable substrates (1 hr)
 2. Catabolism of glucose (3 hr)
 - A. Pathways of glucose degradation: EMP, ED & PP pathway
 - B. Fate of pyruvate under aerobic as well as anaerobic conditions
 3. Tricarboxylic acid (TCA) cycle (3 hr)
 - A. Catabolic role of TCA cycle
 - B. Anabolic role of TCA cycle: Glyoxalate bypass and its significance
 4. Catabolism of fatty acids and proteins (3 hr)
 - A. β -oxidation of fatty acids
 - B. Catabolism of amino acids: Deamination, decarboxylation, transamination, stickland reaction

Unit III. Chemoautotrophic and Phototrophic metabolism

1. Physiological groups of chemolithotrophs (1 hr)
2. Generation of ATP & reducing power in chemoautotrophs (forward and reverse etc) (2 hr)
3. Phototrophic metabolism (7 hr)
 - A. Physiological groups of phototrophs
 - B. Photosynthetic apparatus in photosynthetic eubacteria, cyclic and noncyclic photophosphorylation
 - C. Photophosphorylation in halobacteria
 - D. Pathways for CO₂ fixation
 - i. Calvin cycle,
 - ii. Reductive TCA cycle

Unit IV. Biosynthesis

1. Principles governing biosynthesis (3 hr)
 - A. Role of precursor metabolites, ATP, reducing power and their role
 - B. Anaplerotic reactions and their role in biosynthesis
2. Assimilation of ammonia, nitrate, molecular nitrogen and sulfate (2 hr)
3. Biosynthesis of saturated and unsaturated fatty acids (1 hr)
4. Polymerization of (3 hr)
 - A. Amino acids into polypeptides
 - B. Nucleotides into polynucleotide
 - C. Fatty acids into lipids
 - D. Biosynthesis of peptidoglycan
5. Methods of studying biosynthesis (1 hr)
 - A. Use of biochemical mutants, isotopes, pulse labeling and metabolic inhibitors

Text Books:

1. Stanier R Y, Adelberg E A and Ingrahm J L, (1991), *General Microbiology*, 5th edn. Mac Millan Press Inc
2. Prescott L, Harley J P, and Klein D A, (2008), *Microbiology*, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA

Semester- V
Course MI-303
Principles of Immunology

Unit I. Immunity and Immune response

1. Immunity (3 hr)
 - A. Concept of innate (native) and acquired (adaptive) immunity
 - B. Types of immunity
 - C. Innate immunity: species, racial and individual
 - D. Acquired immunity: active and passive; natural and artificial
 - E. Concept of herd immunity
2. Immune response (IR) (3 hr)
 - A. Concept and basic functions of IR, two arms (branches) of IR: Antibody mediated (humoral) and cell mediated immune (CMI).
 - B. Characteristics of IR: Discrimination, diversity, specificity, memory and transferability
 - C. Primary and secondary IR
3. Cells and organs of immune system (2 hr)
 - A. Lymphocytes as main actors; Types of lymphocytes, B-cells, T-cells and Null cells
 - B. Importance of antigen presenting cells in IR
 - C. An introduction to the primary (central) and secondary (peripheral) lymphoid organs
4. Introduction to the advanced concept of immunology (2 hr)
 - A. MHC and HLA
 - B. Clonal selection
 - C. Monoclonal antibodies

Unit II. Antigens, Antibodies and their Reaction

1. Antigens (3 hr)
 - A. Concept of antigen, immunogen and hapten
 - B. Physico-chemical and biological properties of antigens
 - C. Various types of antigens
 - D. Antigens occurring in bacterial cell
2. Antibodies (3 hr)
 - A. Concept of antibody, immunoglobulin and myeloma proteins
 - B. Basic structure of antibodies
 - C. Classes of immunoglobulins: Physicochemical and biological properties
 - D. Antibody diversity

3. Antigen-antibody reactions (serological reactions) & other immunological tests (4 hr)
 - A. Mechanism of antigen-antibody reactions (zone phenomenon); Concept of lattice formation
 - B. Principles and applications antigen-antibody reactions
 - i. Precipitin reaction
 - ii. Agglutination reaction
 - iii. Complement fixation reaction
 - iv. Immunofluorescence
 - v. Enzyme Linked Immunosorbant Assay (ELISA)
 - vi. Radio Immunoassay (RIA); Radio-Allergo-Sorbent test (RAST)
 - vii. Western blot technique
 - C. Various skin tests
 - D. Measurement of cell mediated immune response (CMI)

Unit III. Immune Disorders

1. Concept of hyper and hypo functioning of immune system (1 hr)
2. Types immune disorders
 - A. Hypersensitivity (3 hr)
 - B. Autoimmunity and autoimmune disorders (1 hr)
 - C. Immunodeficiency (3 hr)
 - D. Tumor immunity (1 hr)
 - E. Transplantation immunity, concept of immune suppression (1 hr)

Unit IV. Immunohaematology and Immunoprophylaxis

1. Immunohaematology (5 hr)
 - A. Concept of immunohaematology: Various blood group antigens and the blood groups
 - B. Importance of blood groups in blood transfusion, inheritance & anthropology
 - C. A brief introduction to the concept of blood banking
 - D. An outline of blood constituents
2. Immunoprophylaxis (5 hr)
 - A. Concept of immunoprophylaxis
 - B. Types of vaccines
 - C. Schedule of vaccination
 - D. Hazards of vaccination

Text Books:

1. Atlas R M, (1997), *Principles of Microbiology*. 2nd edn, Wm. C. Brown Pub., Iowa, USA.
2. Prescott L, Harley J P, and Klein D A, (2008), *Microbiology*, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA.

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Semester- V
Course MI-304
Bioprocess Technology

Unit I. Introduction to Bioprocess

1. Concept of fermentation and changing phases in industrial microbiology (2 hr)
2. Stages in development of fermentation process (component parts) (2 hr)
3. Range of fermentation processes (2 hr)
4. Screening of industrially important organisms (4 hr)
 - A. Characteristics of an industrially ideal organism
 - B. Primary screening of amylase, organic acid, antibiotics and amino acid producers
 - C. Introduction to secondary screening

Unit II. Fermentation media

1. Introduction (5 hr)
 - A. Principles of media formulation
 - B. Media ingredients: Water, carbon sources, nitrogen sources, minerals, growth factors, buffers, precursors, inducers, inhibitors, antifoam agents
2. Sterilization of media (3 hr)
 - A. Use of high-pressure steam: Principle, batch and continuous sterilization process
 - B. Use of filtration: Principle, types of filters
3. Inoculum development: General principles for development of seed culture (2 hr)

Unit III. Bioreactor Design & Fermentation Economics

1. Stirred tank Bioreactor (6 hr)
 - A. Essential features of a bioreactor (basic functions)
 - B. Body construction
 - C. Devices for aeration and agitation, pH, temperature, foam and dissolved oxygen
 - D. Bioreactor for specialized purposes: Airlift, Tower & Biocatalytic Reactors
2. Design of batch fermenter and continuous fermenter (2 hr)
3. Introduction to fermentation economics (2 hr)

Unit IV. Modes of Operations & Control parameters

1. Modes of Operations: Open and closed fermentation, surface culture fermentation, submerged culture (batch, fed-batch & continuous) fermentation, solid substrate fermentation (6 hr)
2. Operating parameters and their control: Aseptic operation, mass transfer of oxygen, foam, pH & temperature (4 hr)

Text Books:

1. Stanbury P F, Whitaker A, and Hall S J, (1995). *Principles of Fermentation Technology*, 2nd edn, Pergamon Press, London, UK
2. Waites M J, and Morgan N L, (2002). *Industrial Microbiology: An Introduction* Blackwell Science
3. Crueger W and Crueger A, (2000), *Biotechnology: A Text Book of Industrial Microbiology*, 2nd edn, Panima Publishing Corporation, New Delhi, India
4. Trevan M D, Boffey S, Goulding K H, and Standury S, (eds), (1987), *Biotechnology: The Biological Principles*, Tata McGraw-Hill, New Delhi, India
5. Casida L E, Jr. (1968). *Industrial Microbiology*, Wiley Eastern Ltd, New Delhi, India

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Semester- V
Course MI-305.1
Agricultural Microbiology

Unit I. Nature of soil

1. Soil structure and composition (2 hr)
2. Soil as microenvironment, soil organic matters and humus, soil pores and movement of gases for microbial activity (2 hr)
3. Microbes on soil surface and in different zones of soil (1 hr)
4. Soil aggregation, role of microorganisms there in (1 hr)
5. Decomposition of plant and animal residues by microorganisms in soil humus formation (2 hr)

Unit II. Microbial Interaction

1. Neutral, positive and negative association: Symbiosis, neutralism, commensalism, competition, ammensalism, synergism, and parasitism (5 hr)
2. Microorganisms in the rhizosphere, root surfaces and phylloplane, and their significance, mycorrhiza (3 hr)

Unit III. Role of Microorganisms in Soil Fertility and Control of Plant Pathogens and Pematodes

1. Soil fertility (5 hr)
 - A. Soil fertility and phenomenon of mineralization and immobilization of elements, factors affecting soil fertility
 - B. Role of nitrogen fixers, nitrifying, ammonifying, denitrifying, phosphate solubilizing and plant growth promoting bacteria
 - C. Use of microorganisms as biofertilizers: Types of biofertilizers, how biofertilizers work, methods of application advantages and disadvantages, constrains in use, benefits of use
2. Biological control of plant pathogens and nematodes (3 hr)
 - A. Microbial pesticides, organisms having potential of use advantages and disadvantages
 - B. Entomopathogenic fungi

Unit IV. Plant Pathology

1. Types of plant pathogens (2 hr)
2. Mode of entry of plant pathogen in to plant host, plant disease resistance (2 hr)
3. General symptoms, transmission and control of plant diseases (4 hr)

Text Books:

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986), *Microbiology*, 5th edn, McGraw-Hill Book Company, NY
2. Alexander M, (1977), *Introduction to Soil Microbiology*, 2nd edn, Wiley Eastern Ltd.
3. Subbarao N S, (1993), *Biofertilizers in Agriculture and Forestry*, 3rd edn, Oxford and IBH.
4. Atlas R M, (1997), *Principles of Microbiology*. 2nd edn, Wm. C. Brown Pub, Iowa, USA.
5. Mehrotra R and Aggarwal A, (2003), *Plant Pathology*, 2nd edn, Tata Mcgraw-Hill Publisher

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Semester- V
Course MI-306
Microbiology Practicals

1. Isolation of *lac⁻* mutants of *Escherichia coli* using UV radiations as mutagen
2. Isolation of pigmentless mutant of *Serratia marcescens* using UV radiations as mutagen
3. Isolation of streptomycin resistant mutants of *Escherichia coli* by gradient plate method
4. Isolation of DNA
5. Estimation of glucose by Cole's method
6. Estimation of glucose by Nelson-Somogy's method
7. Estimation of protein by Folin-Lawry's method
8. Estimation of streptomycin by sodium nitroprusside method
9. Study of agglutination reaction: Widal test by slide agglutination and double dilution method
10. Demonstration of agar gel immunodiffusion precipitation reaction
11. Determination of human blood group: ABO and Rh systems
12. Estimation of hemoglobin by Sahli's acid hematin method
13. Total count of erythrocytes and leucocytes
14. Differential count of leucocytes by Field's method
15. Primary screening of amylase producers
16. Primary screening of organic acid producers
17. Primary screening of antibiotic producers by crowded plate method
18. Determination of OTR under static, sparging and shake flask condition by sulfite oxidation method

Scheme for Examination

<u>Ex</u>		<u>Marks</u>
1.	Bacterial Genetics	15
	or	
	Bioprocess Technology	
2.	Immunology	15
3.	Metabolism	15
4.	Spotting	10
5.	Viva	10
6.	Journal and slides	<u>05</u>
	Total	70

Semester- VI
Course MI-307
Genetic Engineering and Biotechnology

Unit I. Fundamentals

1. Introduction (1 hr)
2. Tools (6 hr)
 - A. Enzymes: Restriction endonuclease, reverse transcriptase, terminal transferase, alkaline phosphatase, ligases.
 - B. Vectors: Definition, criteria for selection of DNA vectors, Types of vectors: plasmid vector (pBR 322), phage vector (λ), cosmid, shuttle vector-YEP & Ti plasmid
 - C. Genetic probes Oligonucleotides
3. Site directed mutagenesis (1 hr)
4. Polymerase chain reaction (2 hr)

Unit II. Construction of rDNA and its Transfer to Host Cell

1. Obtaining desired DNA fragment- Isolation from host, cDNA preparation and DNA synthesis. (2 hr)
2. Protocol for joining isolated DNA with vector. (2 hr)
3. Transfer of rDNA in to suitable host cell- transfection, gene gun, microinjection, protoplast fusion and electroporation. (3 hr)
4. Selection of recombinant population: Use of marker genes and X- gal dye, colony hybridization, Gene probe: Southern blot & Western blot technique (3 hr)

Unit III. Biotechnology and Techniques Employed

1. Introduction to biotechnology (1 hr)
2. Tissue culture: Plant and animal tissue culture (2 hr)
3. Analytical methods: Chromatography, electrophoresis, spectroscopy, molecular hybridization, DNA microarrays, ELISA, RIA, RAST (7 hr)

Unit IV. Areas of Application of Biotechnology

1. Agricultural biotechnology: Biofertilizers, bioinsecticides, genetically modified/transgenic plants (3 hr)
2. Enzyme biotechnology: Analytical, industrial and therapeutic applications (3 hr)
3. Environmental biotechnology: Bioremediation, biofuels and bioleaching, MEOR (2 hr)
4. Intellectual property rights and biotechnology (1 hr)
5. Ethical issues of biotechnology. (1 hr)

Text Books:

1. Trevan M D, Boffey S, Goulding K H and Standury S, (eds), (1987). *Biotechnology: The Biological Principles*, Tata McGraw-Hill, New Delhi. India
2. Prescott L, Harley J P and Klein D A, (2008), *Microbiology*, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA
3. Atlas R M, (1997), *Principles of Microbiology*. 2nd edn., Wm. C. Brown Pub, Iowa, USA.

Semester- VI
Course MI-308
Virology and Mycology

Unit I. Viruses: General

1. General characteristics and structural organization of virus (2 hr)
2. Cultivation of viruses: (2 hr)
 - A. Animal cultivation
 - B. Cultivation in embryonated eggs,
 - C. In vitro culture: Cell Lines, primary and secondary cell lines, continuous cell lines, cytopathic effects
 - D. Cultivation of bacteriophages
3. Enumeration (assay) of viruses: Methods of enumeration of viruses (2 hr)
4. Classification of viruses: PCNV, ICNV and Cryptogram system of viral classification (2 hr)
5. Sub-viral entities: Viroids, virusoids, prions, introduction to persistent, latent and slow viruses, oncogenic viruses (2 hr)

Unit II. Bacterial / Plant / Animal Viruses

1. Bacteriophage lytic cycle (T4 Phage) (3hr)
 - A. One step growth curve experiment, burst size
 - B. Phage adsorption and penetration, intracellular development, early and late events, replication of phage chromosome, phage morphogenesis and release
 - C. Host induced modifications
 - D. Introduction to single stranded DNA and RNA phages ϕ X174 and MS2
2. Bacteriophage lysogenic cycle (lambda phage): Mechanism of establishment of lysogeny, induction of lysogeny, phage-conversion, replication of lambda phage (2 hr)
3. Plant Viruses: Introduction and replication of plant viruses (TMV) (1 hr)
4. Animal viruses (4 hr)
 - A. Introduction and replication (adsorption, penetration, uncoating, replication, synthesis and assembly, and release) of animal viruses in general (HIV)
 - B. Consequences of viral infection
 - C. Persistent infection, latent infection, transformation and viral interference

Unit III. Fungi: General

1. General characters: Somatic structure, ultra-structure of fungal cell, hyphal modification (4 hr)
2. Cultivation of fungi: (3 hr)
 - A. Principles of fungal nutrition
 - B. Cultivation media and methods, slide culture technique, prevention of bacterial contamination
 - C. Preservation of fungi
3. Importance of fungi: (3 hr)
 - A. Primary and secondary metabolites of fungi and its importance,
 - B. Diseases caused by fungi in plants and animals

Unit IV. Fungi: Reproduction and Classification

1. Reproduction in fungi: Asexual and sexual methods of reproduction, parasexuality among fungi, fruiting bodies in fungi (3 hr)
2. Fungal classification: Criteria used for classification, recent classification system, criteria used for classification, recent classification system (2 hr)
3. Brief outline of different classes of fungi: (Structure, habitat, reproduction/life cycle and economic importance in general) (5 hr)
 - A. Phycomycetes (Phycomycotina)
 - B. Ascomycetes (Ascomycotina)
 - C. Basidiomycetes (Basiomycotina)
 - D. Deutromycetes (Duteromycotina)
 - E. Slime molds

Text Books:

1. Alexopoulos C J, Mims C W, Blackwell M, (1996), *Introductory Mycology*, 4th ed., Blackwell Publishing
2. Sharma O P, (1989), *Textbook of Fungi*, Tata McGraw-Hill Publishing Co. Ltd
3. Dube H C, (1990), *An Introduction to Fungi*, 2nd edn, Vikas Publishing House Pvt Ltd
4. Biswas S B, Biswas A, *An Introduction to Viruses*, 3rd ed., (1984), Vani Educational Books, New Delhi
5. Atlas R M, (1997), *Principles of Microbiology*. 2nd edn., Wm. C. Brown Pub., Iowa, USA.
6. Prescott L, Harley J P, and Klein D A, (2008), *Microbiology*, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA

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Semester- VI
Course MI-309
Medical Microbiology

Unit I. Host-Parasite Relationship

1. Concept of host- parasite Relationship (2 hr)
2. Microbial pathogenicity (4 hr)
 - A. Overview of bacterial and viral pathogenicity
 - B. Factors affecting the process of infection
 - C. Pathogenicity
 - i. Invasiveness: Role of structures and secretions of bacteria
 - ii. Toxicogenicity: Protein and LPS toxins; their properties and mode of action
3. Non-specific host defenses (4 hr)
 - A. First line of (primary) defense: Physical and mechanical defense; role of skin and mucus membrane
 - B. Second line of (secondary) defense: cellular and chemical; defenses

Unit II. Microbiota of Human Body and Epidemiology

1. Normal microbiota of human body (3 hr)
 - A. Importance, origin and establishment
 - B. Microbiota of various body parts
 - C. Gnotobiotic life and gnotobiosis
2. Epidemiology of infectious disease (7 hr)
 - A. Concept of Epidemiology
 - B. Epidemiological types of infections
 - C. Techniques used to study epidemiology
 - D. Epidemiological markers
 - E. Disease cycle
 - F. Nosocomial infections: sources, transmission and their control

Unit III. Microbial Diseases of Human Being

1. Airborne infections: Tuberculosis, influenza (2 hr)
2. Food and waterborne infections: Typhoid fever, food poisoning, hepatitis (2 hr)
3. Contagious diseases: Syphilis, AIDS (2 hr)
4. Arthropod borne diseases: Plague, yellow fever, malaria (2 hr)
5. Zoonoses: Rabies, anthrax (2 hr)

Unit IV. Clinical Microbiology

1. Specimen: Types of specimen, method of collection, storage and transport (1 hr)
2. Methods used for diagnosis and identification of pathogen
 - A. Microscopy (2 hr)
 - B. Growth and biochemical characteristics (2 hr)
 - C. Clinical immunology (2 hr)
 - D. Pathological changes in blood, body fluids and tissues (2 hr)
 - E. Significance of computer and possible use of biosensors (1 hr)

Text Books:

1. Prescott L, Harley J P, and Klein D A, (2008), *Microbiology*, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA.
2. Baker F J, Silvertown R E, Pallister C J, (1998), *Baker and Silvertown's Introduction to Medical Laboratory Technology*, 7th edn, Butterworths-Heinemann, Oxford, UK
3. Tortora G J, Funke B R, Case C L, (2008), *Microbiology: An Introduction*, 8th edn, Benjamin Cummings

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Semester- VI
Course MI-310
Fermentation Technology

Unit I. Strain Improvement

1. Introduction (1 hr)
2. Strategies of strain improvement (5 hr)
 - A. Selection and adaptation
 - B. Selection of induced mutants
 - C. Selection of recombinants
3. Strain improvement for modification of properties other than yield (2 hr)
4. Preservation of industrially important organism: Principle, methods and quality control (2 hr)

Unit II. Downstream Processing

1. Introduction to downstream processes: Problems and designing (1 hr)
2. Removal of microbial cells and suspended solids (3 hr)
 - A. Foam separation
 - B. Precipitation
 - C. Filtration
 - D. Centrifugation
3. Cell disruption methods (2 hr)
 - A. Introduction
 - B. Physico-mechanical methods
 - C. Chemical methods
4. Product concentration and purification (3 hr)
 - A. Liquid-liquid extraction
 - B. Chromatography
 - C. Membrane processes
5. Finishing stages (1 hr)
 - A. Drying
 - B. Crystallization

Unit III Quality Assurance and Safety Measurement

1. Quality assurance of products (3 hr)
 - A. Bioassay
 - B. Sterility testing
 - C. Pyrogen testing
2. Manufacturing and environment safety (5 hr)
 - A. Containment
 - B. Clean room environment
 - C. Effluent treatment
3. Introduction to scale-up (2 hr)

Unit IV. Typical Fermentation Processes

1. Penicillin fermentation (2 hr)
2. Citric acid fermentation (2 hr)
3. Ethanol fermentation (2 hr)
4. Vitamin B12 fermentation (1 hr)
5. Lysine fermentation (2 hr)
6. Amylase fermentation (1 hr)

Text Books:

1. Stanbury P F, Whitaker A and Hall S J, (1995), *Principles of Fermentation Technology*, 2nd edn, Pergamon Press, London, UK
2. Waites, M J and Morgam N L, (2002), *Industrial Microbiology: An Introduction*, Blackwell Science
3. Crueger W and Crueger A, (2000), *Biotechnology: A Text Book of Industrial Microbiology*, 2nd edn, Panima Publishing Corporation, New Delhi, India
4. El-Mansi E M T, Bryce C F A, Dahhou B, Sanchez S, Demain A L, Allman A R (eds), (2011), *Fermentation Microbiology and Biotechnology*, 3rd edn, CRC Press; Taylor and Francis Group, Boca Raton
5. Casida L E, Jr. (1968). *Industrial Microbiology*, Wiley Eastern Ltd, New Delhi, India

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Semester- VI
Course MI-311.1
Geomicrobiology

Unit I. Microbial Habitats and Zonation	
1. Introduction to geomicrobiology	(1 hr)
2. Earth as microbial habitat	(2 hr)
3. Lithosphere as microbial habitat	(2 hr)
4. Hydrosphere as microbial habitat	(2 hr)
Unit II. Methods in Geomicrobiology and Geomicrobial Processes Overview	
1. Non-molecular methods for geomicrobially important microorganisms	(2 hr)
2. Molecular methods for geomicrobially important microorganisms	(2 hr)
3. Geomicrobially important physiological groups of prokaryotes and their activity	(2 hr)
4. Introduction of microbes as catalysts of geochemical processes	(1 hr)
Unit III. Geomicrobial Interactions	
1. Biogenesis of minerals: Natural origin of metal sulphides, principles of metal sulphide formation and laboratory evidences.	(1 hr)
2. Biodegradation of minerals	(4 hr)
A. Biooxidation of metal sulphides	
B. Bioleaching of copper ore	
C. Acid mine drainage	
3. Biobeneficiation	(2 hr)
Unit IV. Geomicrobiology of Fossil Fuel	(1 hr)
1. Natural fossil fuels	
2. Geomicrobiology of methane	(2 hr)
3. Role of microbes in peat formation and conversion	(2 hr)
4. Role of microbes in coal formation and desulphurization	(2 hr)

Text Books:

1. Ehrlich H L, Newman D K, (2009), *Geomicrobiology*, 5th edn, Boca Raton, FL: CRC Press/Taylor & Francis
2. Konhauser K, (2007), *Introduction to Geomicrobiology*. Oxford: Blackwell
3. Natarajan K A, (1998), *Microbes, Minerals and Environment*, 1st edn, Geological Survey of India, Bangalore

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Semester-VI
Course MI-312
Microbiology Practicals

1. Separation of amino acids by paper chromatography
2. Separation of amino acids by thin layer chromatography
3. Demonstration of separation of components of India ink by paper electrophoresis
4. Immobilization of cells by calcium-alginate entrapment method and demonstration of activity by methylene blue reduction test
5. Use of enzyme as analytical tool: Glucose estimation by GOD-POD method
6. Isolation of bacteriophage from sewage
7. Isolation and cultivation of yeasts
8. Cultivation of and microscopic examination of molds by slide culture technique
9. Cultivation and microscopic examination of molds—*Neurospora*, *Fusarium*, *Alternaria*, *Curvularia* and *Helminthosporium*
10. Study of plant diseases caused by Virus and Fungi—Mosaic, red rot, rust, smut, wilt, leaf curl, powdery mildew, downy mildew
11. Isolation, cultivation and identification of gram-negative bacteria—*Escherichia coli*, *Enterobacter aerogenes*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Salmonella paratyphi A*, *Salmonella paratyphi B*
12. Demonstration of characterization of Gram-negative bacteria based on biochemical reactions using rapid identification kit
13. Study of antibiogram (using multidisk)
14. Physical and chemical analysis of urine
15. Estimation of blood urea by diacetyl monoxime method (DAM)
16. Study of permanent slides
 - A. Insect vectors: Female anopheles mosquito, head louse, yick, flea, mite.
 - B. Microorganisms: Actinomycetes, yeast, bacteroids, acid-fast bacilli, spirochetes, *Streptococcus pneumoniae*, *Clostridium tetani* and *Plasmodium vivax*
17. Fermentative production of amylase and its activity check
18. Demonstration of recovery of crude protein / amylase from fermentation broth either by salting out (ammonium sulfate) or by using isopropyl alcohol
19. Bioassay of penicillin using *Bacillus subtilis*
20. Sterility testing of pharmaceutical product

Scheme for Examination

<u>Ex</u>	<u>Marks</u>
1. Isolation and identification of Gram negative bacteria	15
2. Mycology / Virology	10
3. Fermentation technology	10
4. General exercise (any one)	10
A. Separation techniques	
B. Estimation of glucose by GOD POD method	
C. Estimation of Blood Urea by DAM method	
D. Urine analysis	
E. Determination of antibiogram	
5 Spotting	10
6 Viva	10
7 Journal and slides	<u>05</u>
Total	70