DEPARTMENT OF MICROBIOLOGY

Syllabus for Three Years Bachelor Degree Course

(Implemented from the Academic Year 2020 onwards)

CHOICE BASED CREDIT SYSTEM (CBCS)

SYLLABUS FOR BACHELOR IN SCIENCE

IN

MICROBIOLOGY

YBNUNIVERSITY

Established by the Act of Government of Jharkhand Act 15, 2017

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As per Section 2(f) of UGC Act. 1956

Department of Microbiology
YBN University, Ranchi

Syllabus for B.Sc. (H), Microbiology

Year	Semester	Paper	Nomenclature	Max. Marks 100	Theory		Practicals
					E	M	
B.Sc. Part-I	Semester I	Paper I	General M icrobiology with practicals	100	60	15	25
		Paper II	Phycology and Virology I with practicals	100	60	15	25
	Semester II	Paper III	Mycology and Virology II with practicals	100	60	15	25
		Paper IV	Cell Biology with practicals	100	60	15	25
B.Sc. Part-II	Semester III	Paper V	M icrobial Physiology and Biochemistry with practicals	100	60	15	25
		Paper VI	Plant Pathology with practicals	100	60	15	25
	Semester IV	Paper VII	M icrobial Genetics with practicals	100	60	15	25
		Paper VIII	Immunology with practicals	100	60	15	25
	Semester V	Paper IX	M icrobial Ecology and Biostatistics	100	80	20	
		Paper X	M olecular Biology and Bio-informatics	100	80	20	
		Paper XI	Industrial M icrobiology	100	80	20	

		Paper XII	Practicals based on Paper IX, Paper X and Paper XI	100			
B.Sc Part III	Semester VI	Paper XIII	Recombinant DNA Technology and Genetic Engineering	100	80	20	
		Paper XIV	Food and Dairy M icrobiology	100	80	20	
		Paper XV	M edical M icrobiology	100	80	20	
		Paper XVI	Practicals based on Paper XIII, Paper XIV and Paper XV	100	50 Project + 50 Lab.		
			Total Marks	**1600**			

M – Mid Semester Exam; **E – End Semester Exam**

Paper I
General Microbiology

Unit 1 History, taxonomy and Classification of Microbiology

(5 periods)

- History of Microbiology- Contributions of pioneers. (Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty).
- Spontaneous generation vs. biogenesis. **(2 periods)**
- Diversity of Microbial world: Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. **(3 periods)**
- Difference between prokaryotic and eukaryotic microorganisms. General characte ristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

(5 periods)

- Bacterial Systematics: - Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria. Introduction to Bergey's manual of determinative and systematic classification. **(5 periods)**

Unit 2. Bacterial Cell Organization (10 periods)

- Cell organization : Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.
- Structure of Cell-wall: Composition and detailed structure of gram positive and gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.
- Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.

Unit 3. Bacteriological techniques (5 periods)

- Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria..
- Microscopy and Staining tecniques: Bright Field, Dark Field, Phase Contrast, Fluorescence and Scanning and Transmission Electron Microscopy.
- Staining Techniques : Stains and Dyes: Classification and Types.

Unit 4. Growth, Nutrition and Reproduction in Bacteria (5 periods)

- Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.
- Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 5. Microbial Diversity **(8 periods)**

• Bacteria with unusual properties- *Rickettsia*, *Chlamydia*, *Mycoplasma*, Archaebacteria, Cyanobacteria, Actinomycetes.

• Microbes of extreme environments– Adaptations and industrial importance of Thermophiles, Alkalophiles and Halophiles.

Paper II
PHYCOLOGY & VIROLOGY I

Section A: Phycology

Unit 1. Classification of Algae **(2 periods)**

Unit 2. Study of the following classes with reference to genera listed below: (occurrence, thallus organization and life cycles):

a) Chlorophyceae: *Volvox, Coleochaete* **(3 periods)**
b) Charophyceae: *Chara* **(3 periods)**
c) Diatoms: General features with reference to pinnate and centric diat oms **(3 periods)**
d) Xanthophyceae: *Vaucheria* **(2 periods)**
e) Phaeophyceae: *Ectocarpus* **(2 periods)**
f) Rhodophyceae: *Polysiphonia* **(2 periods)**
g) Cyanobacteria: *Nostoc, Anabaena, Spirulina, Oscillatoria* **(3 periods)**

Unit 3. Applications of algae in Agriculture, Industry, Environment and Food **(3 periods)**

Section B: VIROLOGY

Unit 4. Introduction: Discovery of viruses, nature and definition of viruses, general properties of viruses. Concept of viroids, virusoids, satellite viruses and prions. Theories of viral origin. **(6 periods)**

Unit 5. Structure of viruses: Capsid symmetry, enveloped and non-enveloped viruses. **(3 periods)**

Unit 6. Isolation, purification and cultivation of viruses. **(2 periods)**

Unit 7. Viral Taxonomy: Classification and nomenclature of different groups of viruses infecting microbes, plants and animals. **(5 periods)**

Unit 8. Salient features of viral genomes: Unusual bases (TMV, T4 phage), overlapping genes (ΦX174, Hepatitis B virus), alternate splicing (Picornavirus), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), ambisense genomes (arenavirus), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (influenza virus) and non segmented genomes (picornavirus), capping and tailing (TMV). **(5periods)**

Paper III
VIROLOGY II and MYCOLOGY

Section A: VIROLOGY II

Unit 1. Bacteriophages **(4 periods)**

Unit 2. Viral multiplication and replication strategies **(5 periods)**

Unit 3. Transmission of viruses: Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda and P1 phage), concept of early and late proteins, regulation of transcription in lambda phage and applications of bacteriophages. **(5 periods)**

Unit 4. Oncogenic viruses: Types of oncogenic DNA and RNA viruses. Concepts of oncogenes, protoncogenes and tumor suppressor genes. **(3 periods)**

Unit 5. Prevention and control of viral diseases, Antiviral compounds, interferons and viral vaccines. Applications of Virology: Use of viral vectors in cloning and expression, Gene therapy and Phage display. **(8 periods)**

Section B: Mycology

Unit 6. Classification of fungi **(2 periods)**

Unit 7. Study of the following classes with reference to the genera listed below
(occurrence, somatic structure and life cycles):

a) Cellular slime molds – Dictyostelium **(2 periods)**
b) True slime molds (Myxomycetes) – *Physarum* **(2 periods)**
c) Oomycetes - *Saprolegnia, Phytophthora* **(3 periods)**
d) Chytridiomycetes – *Neocallimastix* **(2 periods)**
e) Zygomycetes – Mucor **(1 periods)**
f) Ascomycetes - *Saccharomyces*, *Penicillium*, *Neurospora* **(3 periods)**
g) Basidiomycetes – *Agaricus* **(2 periods)**
h) Deuteromycetes - *Candida*, *Alternaria* **(2 periods)**

Unit 8. Lichens **(3 periods)**

Unit 9. Economic importance of fungi with examples in Agriculture, Environment, Industry, Medicine, Food, Biodeterioration (of wood, paper, textile, leather), Mycotoxins **(5 periods)**

Paper IV

Cell Biology

Unit 1. Tools and techniques of Cell Biology **(10 periods)**

- Microscopic-Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy;Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy;
- Analytical-Flow cytometry- flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis.
- Separation-Sub-cellular fractionation- differential and density gradient centrifugation; Chromatography- paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC).

Unit 2. Composition of Cells: **(15 periods)**

- Cell Wall, the Extracellular Matrix and Cell Interactions
- Molecules of cell, cell membranes and cell Proteins, Structure; Transport of small molecules, Endocytosis
- The Nucleus Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.
- Mitochondria, Chloroplasts and Peroxisomes- Structural organization, Function, Marker enzymes,Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes'assembly..

Unit 3. Protein Sorting and Transport - The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes. **(6 periods)**

Unit 4. Cytoskelton and Cell Movement - Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules. **(4 periods)**

Unit 5. Cell Signaling - Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks. **(5 periods)**

Unit 6. The Cell Cycle- Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis. **(3 periods)**

Unit 7. Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning. **(4 periods)**

Unit 8. Cancer- Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach. **(2 periods)**

Paper V

Microbial Biochemistry and Physiology

Unit 1. Biomolecules

a) Carbohydrates- Chemical structure, nature and properties, classification and importance in biological cells
b) Amino acids and proteins- Chemical structure, nature and properties, classification, proteolysis, transamination, deamination
c) Lipids and hormones- Saturated and unsaturated fatty acids, structure, classification, properties and function of lipids, □□oxidation of lipids
   Hormones: steroid hormones, structure and fuction
d) Nucleic Acid: Basic constituent of DNA, RNA- mRNA, tRNA, rRNA

Unit 2. Microbial Enzyme

a) Nature and structural properties, Nomenclature and classification.
b) Enzyme kinetics- Energy of Activation, catalytic site, Interaction of enzyme substrate, Km, Inhibition, Activation.
c) Factors affecting Enzyme activity: Enzyme concentration, substrate concentration, Temperature, pH

Unit 3. Microbial growth

a) Definition of growth, growth curve, Mathematical expression of growth, rate, generation time.
b) Batch and continuous culture, synchronous growth, diauxic growth.
c) Factors affecting microbial growth such as temperature, pH, O_2 concentration, radiation, pressure.

Unit 4. Microbial Energetic

a) Principal of bioenergetics and high energy phosphate compound. Mode of energy production- phosphorylation
b) Concept of anabolism and catabolism
c) Chemoorganotrophic catabolic process or energy yielding process, Aerobic respiration: Glycolysis, EM pathway, PP pathway, TCA, Electron transport and oxidative phosphorylation. Anaerobic respiration, fermentation
d) Phototrophy- Light reaction in oxygenic photosynthesis, light reaction in anoxygenic photosynthesis.

a) Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation.

b) Nitrogen fixers and mechanism of nitrogen fixation, properties of nitrogenase, and ammonia assimilation.

c) Genetics of nitrogen fixation and regulation of nitrogenase activity and synthesis.

Paper VI
Plant Pathology

Unit 1 Introduction and History of plant pathology: Concept of plant disease - definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseas.

(4 periods)

Unit 2 Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation. **(1 periods)**

Unit 3 Host Pathogen Interaction:

A. Microbial Pathogenicity- Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development.

B. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). **(5 periods)**

C. Genetics of Plant Diseases- Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. **(3 periods)**

D. Defense Mechanisms in Plants- Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins. **(4 periods)**

Unit 5 Control of Plant Diseases: Principles & practices involved in the management of plant diseases by different methods, viz. Regulatory, cultural, chemical, biological

(10 periods)

Unit 6 Specific Plant diseases: Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control. **(9 periods)**

A. Important diseases caused by fungi
White rust of crucifers - *Albugo candida*
Late blight of potato - *Phytophthora infestans*
Powdery mildew of wheat - *Erysiphe graminis*
Ergot of rye - *Claviceps purpurea*
Black stem rust of wheat - *Puccinia graminis tritici*
Loose smut of wheat - *Ustilago nuda*
Red rot of sugarcane - *Colletotrichum falcatum*
Early blight of potato - *Alternaria solani*

B. Important diseases caused by phytopathogenic bacteria, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus **(3 periods)**

C. Important diseases caused by viruses

Tomato yellow leaf curl, banana bunchy top, yellow mosaic vein virus of ladies finger.

(3 periods)

Paper VII
Microbial Genetics

Unit 1. Introduction to Genetics: Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. **(2 periods)**

Unit 2. Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance. **(8 periods)**

Unit 3. Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interferenc e and coincidence. **(5 periods)**

Unit 4. Mutations: Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms. **(5 periods)**

Unit 5. Extrachromosomal Inheritance: Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium. **(6 periods)**

Unit 6. Sex Determination: Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation. **(2 periods)**

Unit 7. Quantitative Genetics- Quantitative and multifactor inheritance, Transgressive variations, Heterosis. **(4 periods)**

Unit 8. Mechanism of genetic exchange : Plasmid and bacterial sex, Types of plasmids (F Plasmid : Conjugate plasmid, Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes. Transposable elements (Insertion sequence and transposons, Integrons and Antibiotic -Resistance cassettes, Multiple Antibiotic Resistant bacteria, Mu–virus). **(8 periods)** Bacterial Genetics (Mutant phenotype, DNA mediated Transformation; Conjugation (Cointegrate Formation and Hfr Cells, Time –of–Entry Mapping, F' Plasmid); Transduction (Generalized transduction, Specialized Transduction)- gene mapping. **(5 periods)**

Unit 9. Population and Evolutionary Genetics: Allele frequencies, Genot ype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift, Variation and Speciation. **(5 periods)**

Paper VIII
Immunology

Unit 1. Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa. **(3 periods)**

Unit 2. Immune Cells and Organs: Structure, Functions and Properties of: Immune cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT. **(6 periods)**

Unit 3. Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants. **(3 periods)**

Unit 4. Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies. **(6 periods)**

Unit 5. Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways). **(5 periods)**

Unit 6. Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation. **(3 periods)**

Unit 7. Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance. **(7 periods)**

Unit 8. Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens. **(6 periods)**

Unit 9. Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR. **(6 periods)**

Paper IX
Microbial Ecology and Biostatistics

Unit 1. Microorganisms & their natural habitats **(8 periods)** A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora.
B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats.
C. Atmosphere: Stratification of the Atmosphere, Aeromic roflora, Dispersal of Microbes.
D. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
E. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.
Unit 2. Succession of microbial communities in the decomposition of plant organic matter. **(2 periods)**

Unit 3. Biological Interactions
A. Microbe–Microbe Interactions: Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents. **(2 periods)**

B. Microbe –Plant Interactions: Roots, Aerial Plant surfaces, Biolog ical Nitrogen fixation (symbiotic/non- symbiotic – biofertilizers) **(3 periods)**
C. Microbe–Animal Interactions: Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont. **(2 periods)**

Unit 4. Biogeochemical cycles an introduction
Carbon cycle: Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin) **(3 periods)**
Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution. **(3 periods)**
Phosphorous cycle: Phosphate immobilization and phosphate solubilization **(1 periods)**
Sulphur Cycle: Microbes involved in sulphur cycle **(1 periods)**

Unit 5. Solid Waste Management: Sources and types of solid waste, methods of disposal of solid waste (incineration, composting, sanitary landfill). **(3 periods)**

Unit 6. Liquid Waste Management: Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, imhoff tank, anaerobic digestor) and tertiary sewage treatment. **(5 periods)**

Unit 7. Biostatistics I: Measure of central tendency- Mean, mode and median; Measure of dispersion- Standard deviation and Standard error; Diagrammatic and graphic representation of frequency distribution. **(6 periods)**

Unit 8. Biostatistics II: Basic idea of probability- Addition and Multiplication laws; Test of significance- Chi square test; Normal distribution and departures from normality. **(6 periods)**

Paper X
Molecular Biology and Bioinformatics

Unit1. Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics. **(4 periods)**

Unit2. The Structures of DNA and RNA / Genetic Material: DNA Structure: Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, Cot curves. DNA topology - linking number, topoisomerases; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA. **(6 periods)**

Unit3. Genome Structure, Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome, Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes . **(8 periods)**

Unit4. The Replication of DNA (Prokaryotes and Eukaryotes) Chemistry of DNA synthesis, general principles - bidirectional replication, Semi-conservative, Semi-discontinuous, RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, Mutability and Repair of DNA. **(8 periods)**

Unit5. Mechanism of Transcription - Transcription in Prokaryotes and Eukaryotes, RNA Modifications, Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport. **(5 periods)**

Unit6. Translation (Prokaryotes and Eukaryotes) - Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Inhibitors of protein synthesis, Regulation of translation. **(6 periods)**

Unit7. Transcription Regulation in Prokaryotes and Eukaryotes - Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons. Conserved mechanism of regulation in Eukaryotes, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing. **(5 periods)**

Unit8. Regulatory RNAs- RNA interference, miRNA, siRNA, Regulatory RNA and X- inactivation **(3 periods)**

Unit9. Introduction to Bioinformatics: Definition and relation to molecular biology, potential and application of bioinformatics.
Databases management and data analysis: Nucleic acid and Protein databases, Structure databases, Specialized (organism and species) databases.
Tools: Sequence alignments- Pair-wise and multiple sequence alignment (Clustal w), sequence similarity search and homology algorithms (BLAST) for protein and nucleic acids. Visualization of protein structure (RASMOL). **(4 periods)**

Paper XI
INDUSTRIAL MICROBIOLOGY

Unit 1 Introduction to industrial microbiology: Brief history and developments in industrial microbiology. **(2 periods)**

Unit 2 Fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fed-batch and continuous fermentations. **(4 periods)**

Unit 3 Bioreactors/fermenters: Components of a typical bioreactor, types of bioreactors - Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. **(7 periods)**

Unit 4 Measurement and control of fermentation parameters: pH, temperature, dissolved oxygen, foaming and aeration. **(4 periods)**

Unit 5 Isolation of industrially important microbial strains: Primary and secondary screening, strain development, preservation and maintenance of industrial strains. **(4 periods)**

Unit 6 Media and ingredients for industrial fermentations: Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract. **(3 periods)**

Unit 7 Down-stream Processing: Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying. **(5 periods)**

Unit 8 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses). Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations. **(13 periods)**

Unit 9 Enzyme immobilization: Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase). **(5 periods)**

Paper XII
Practicals based on Paper IX, Paper X and Paper XI.

Paper XIII
Recombinant DNA Technology and Genetic Engineering

Unit 1 Tools of recombinant DNA technology. **(2 periods)**

A. Hosts: *E. coli* strains; Yeast (*Saccharomyces cerevisiae*); Fungi (*Penicillium*, *Aspergillus*); Mammalian cell lines - names and genotypes. **(2 periods)** B. Enzymes: Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering.
DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease. **(5 periods)**

C. Vectors: Mammalian Expression Vectors SV40, Vaccinia, Retroviral promoter based vectors. **(2 periods)**

Unit 2 Basic DNA Cloning: Simple cloning of DNA fragments, Vectors: Definition and properties. *E. coli* expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors - pET yeast vectors, YIp, YEp and YCp vectors. Baculovirus based vectors. Ti based vectors (Binary and Co integrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation. **(7 periods)**

Unit 3 Methods of gene delivery in plants and animals: Microinjection, biolistic method (gene gun), liposome and viral- mediated delivery, *Agrobacterium*- mediated delivery. Cloning Vectors-Definition and Properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs. **(3 periods)**

Unit 4 Methods of DNA, RNA and Protein analysis and DNA typing: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. **(9 periods)**

Unit 5 Amplification of nucleic acids: Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction. **(4 periods)**

Unit 6 Construction of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR. **(3 periods)**

Unit 7 DNA sequencing and synthesis: Maxam- Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project. **(2 periods)**

Unit 8 Product of DNA technology: Human protein replacements-insulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal. **(4 periods)**

Paper XIV
Medical microbiology

Unit 1 Normal microflora of the human body: Skin, throat, gastrointestinal tract, urogenital tract. **(2 periods)**

Unit 2 Host-pathogen interaction: Definitions of invasion, pathogen, parasite, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection. **(3 periods)**

Unit 3 Sample collection, transport and diagnosis : Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes). **(4 periods)**

Unit 4 Bacterial diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control)
Bacillus anthracis, Corynebacterium diphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and paratyphi, Shigella dysenteriae, Helicobacter pylori, Vibrio cholerae, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Treponema pallidum. **(12 periods)**

Unit 5 Viral diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control) Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza with brief description of bird and swine flu, Dengue, AIDS, Viral cancers.
An overview of emerging v iral Diseases: Japanese Encephalitis, Ebola, Marburg, SARS, Hanta, Nipah, Chandipura, Chikungunya. **(15 periods)**

Unit 6 Introduction to protozoan diseases: Malaria, Kala-azar, and Toxoplasmosis **(3 periods)**

Unit 7 Introduction to fungal diseases: Different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses. **(3 periods)**

Unit 8 Antimicrobial agents and drug resistance: Mechanism of action of important chemotherapeutic agents. Principles of drug resistance in bacteria. **(4 periods)**

Paper XV
Food and Dairy microbiology

Unit 1 Foods as a substrate for microorganisms: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. **(5 periods)**

Unit 2 Microbial spoilage of various foods: Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods. **(5 periods)**

Unit 3 Principles and methods of food preservation: Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. **(10 periods)**

Unit 4 Fermented foods: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh and probiotics. **(10 periods)**

Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonellosis*, *Shigellosis*, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

(8 periods)

Unit 6 Food sanitation and control: HACCP, Indices of food sanitary quality and sanitizers

(2 periods)

Unit 7 Water Potability: Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumpt ive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests. **(5 periods)**

PAPER XVI

Practicals based on Paper XIII, Paper XIV and Paper XV.