

## Department of Biological Sciences, Aliah University, Newtown, Kolkata

### Draft Syllabus for the 3 Years B.Sc. Honours Degree in Microbiology

**(2017 - 2020 onwards batches)**

#### Overall Curriculum

Semester	Theory			Practical		
	Course Code	Course Title	Marks/Credits	Course Code	Course Title	Marks/Credits
I	BM101	Fundamentals of Biochemistry*	50/4	BM 191	<b>Practical I:</b> Biochemistry and General Microbiology	50/4
	BM103	Introduction to Microbiology and Microbial Diversity	50/4			
II	BM102	Cell and Molecular Biology*	50/4	BM 192	<b>Practical II:</b> Cell & Molecular Biology and Bacteriology & Virology	50/4
	BM104	Bacteriology and Virology	50/4			
III	BM201	Microbial Physiology and Metabolism	50/4			
	BM203	Microbial Genetics	50/4			
IV	BM202	Bio-techniques and Bio-statistics*	50/4	BM 292	<b>Practical III:</b> Microbial Physiology and Bio-techniques	50/4
V	BM301	Recombinant DNA Technology	50/4	BM391	<b>Practical IV:</b> Microbial Genetics and Recombinant DNA Technology	50/4
	BM303	Immunology*	50/4	BM393	<b>Practical V:</b> Immunology and Medical Microbiology	50/4
	BM305	Medical Microbiology	50/4			
VI	BM302	Environmental Microbiology	50/4	BM392	<b>Practical VI:</b> Applied Microbiology	50/4
	BM304	Industrial Microbiology	50/4	BM394	<b>Practical VII:</b> Bioinformatics and Project Work	50/4
	BM306	Food and Dairy Microbiology	50/4			
	BM308	Bioinformatics, Biosafety and IPR	50/4			
Total			700/56			350/28
<b>Grand Total</b>	<b>1050 Marks / 84 Credits</b>					

\* Courses (papers) with the asterisks will have the same contents for all the three streams (Botany, Microbiology and Zoology) and will be taught together.

**Each course (paper) will have 60 Hours of Lecture**

## Detailed Syllabus

### Semester I

#### BM101

### Fundamentals of Biochemistry

Total Marks 50, Credits 4

#### Unit 1. Water and Buffer

**No of hours 6**

Physical properties of water, structure of water molecules, Ionization of water, Bronsted – Lowry concept of acid and bases, Concept of pH of weak acids and weak bases, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, buffer value, important biological buffers (with the help of numerical problems). Forces involved in biomolecular interactions with examples: Van der Waals interactions, electrostatic interactions, hydrogen bond and hydrophobic interaction. Configuration versus conformation.

#### Unit 2. Stereochemistry

**No of hours 4**

General concepts on: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature; Projection formula (Fischer & Howarth); Isomers: anomers, epimers; Stereochemistry of cyclohexane: idea of axial & equatorial bonds (related to chair form conformation).

#### Unit 3. Carbohydrates

**No. of Hours: 12**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereoisomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

#### Unit 4. Lipids

**No. of Hours: 8**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

#### Unit 5. Proteins

**No. of Hours: 12**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid; Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together.

#### Unit 6. Enzymes

**No. of Hours: 10**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism. Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Types of enzyme inhibition, competitive- sulfa drugs; non-competitive-heavy metal salts.

## Annexure VI

### Unit 7. Nucleic acid

**No of Hours: 6**

Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA: Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). General structure and types of RNA (tRNA, mRNA, rRNA).

### Unit 8. Vitamins

**No. of Hours: 2**

Classification and characteristics with suitable examples, sources and importance.

### SUGGESTED READINGS:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woelverton C J (2013) Prescott, Harley and Klein's Microbiologyby. 9th Ed., McGrawHill
7. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

## BM103

### Introduction to Microbiology and Microbial Diversity

Total Marks 50, Credits 4

#### Unit 1 History of Development of Microbiology

**No. of Hours: 12**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, Germ theory of disease, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner. An overview of Scope of Microbiology.

#### Unit 2 Concept and Methods of Sterilization (Control of microbial growth)

**No. of Hours 8**

Physical methods of microbial control: heat (moist heat and dry heat) low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. tyndallization. Chemical methods of microbial control: disinfectants, types and mode of action.

#### Unit 3 Basics of Staining and Microscopy

**No of hours 8**

Classification/types of stains; Acidic and Basic dyes, Simple and differential staining, negative staining. Mordants and Chromophores; Principles of Light microscopy: brightfield and darkfield, Phase contrast microscopy.

#### Unit 4: Diversity of Microbial World

**No. of Hours: 32**

##### A. Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three domain classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.

##### B. General characteristics 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.

**Algae:** General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

## Annexure VI

**Fungi:** General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

### Protozoa

General characteristics with special reference to *Amoeba*, *Paramecium*, *Plasmodium*, *Leishmania* and *Giardia*

### SUGGESTED READINGS:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T.Brown Publishers. 6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

## BM 191

### Practical I: Biochemistry and General Microbiology

Total Marks 50, Credits 4

#### Unit I: Biochemistry

1. Concept of molarity, normality, percentage, dilutions, pH and buffers, Preparation of buffers and Numerical problems to explain the concepts.
2. Qualitative tests for the detection of biomolecules: Glucose, Fructose (Benedict's Test); Sucrose (Acid hydrolysis & Benedict's Test); Starch (Iodine Test), Proteins (Biuret method); Amino acids (Ninhydrin); Lipids (Grease Spot Test, Red Test).
3. Study of enzyme kinetics – calculation of  $V_{max}$ ,  $K_m$ ,  $K_{cat}$  values
4. Estimation of amino acid (glycine) by formol titration
5. Study of protein secondary and tertiary structures with the help of models

#### Unit II: General Microbiology

1. Microbiology Good Laboratory Practices and Biosafety.
  2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
  3. Preparation of culture media (Nutrient broth/agar, Luria-bertini broth/agar) for bacterial cultivation.
  4. Sterilization of medium using Autoclave and assessment for sterility.
  5. Sterilization of glassware using Hot Air Oven.
  6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
  7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air and water.
  8. Operation of Light-Microscope; use of oil-immersion objective.
  9. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary/permanent mounts.
  10. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary/permanent Mounts
  11. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.
  12. Simple staining of Bacteria/Yeast and observation under Light Microscope.
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## Semester II

### BM 102

### Cell and Molecular Biology

Total Marks 50, Credits 4

#### Unit 1 Overview of Cell

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

**No. of Hours 2**

#### Unit 2 Structure of Cell

Plasma membrane: Structure and transport of small molecules; Cell Wall: Eukaryotic cell wall, Extracellular matrix; Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

**No. of Hours 8**

#### Unit 3 Cell Organelles

Mitochondria, chloroplasts, lysosomes and peroxisomes; Nucleus: Nuclear envelope, nuclearpore complex, nucleolus and nuclear lamina; Chromatin; Endoplasmic Reticulum and GolgiApparatus.

**No. of Hours 8**

#### Unit 4 Cell Cycle, Cell Death and Cell Renewal

Cell cycle, Mitosis and Meiosis; Development of cancer, Programmed cell death, Stem cells:Embryonic stem cell, induced pluripotent stem cells.

**No. of Hours 8**

#### Unit 5 Structures of DNA and RNA / Genetic Material

DNA structure: Salient features of double helix, Types of DNA, denaturation andrenaturation, cot curves. DNA topology: linking number,twist and writhe. RNA Structure.

**No. of Hours 4**

#### Unit 6 Replication of DNA (Prokaryotes and Eukaryotes)

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends, and other accessory protein. Various models of DNA replication including rolling circle, D- loop (mitochondrial),  $\Theta$  (theta) mode of replication Mismatch and excision repair.Inhibitors of DNA Replication.

**No. of Hours 8**

#### Unit 7 Transcription in Prokaryotes and Eukaryotes

Concept of Operon (lac and trp), Promoter and Operator; Mechanism of Transcription; RNA polymerase, transcription unit; Transcription inEukaryotes: RNA polymerases, general Transcription factors. Inhibitors of Transcription.Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting.

**No. of Hours 10**

#### Unit 8 Post-Transcriptional Processing

Concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping.

**No. of Hours: 4**

#### Unit 9 Translation (Prokaryotes and Eukaryotes)

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis;Translational machinery, charging of tRNA, aminoacyltRNAsynthetases,Mechanisms ofinitiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes,Fidelity of translation; Inhibitors of protein synthesis in prokaryotes and eukaryotes.

**No. of Hours 8**

## Annexure VI

### Suggested Readings:

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8<sup>th</sup> 3 edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. 5 John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8<sup>th</sup> 7 edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5<sup>th</sup> 9 Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
6. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4<sup>th</sup> Edition, Cold Spring Harbour Laboratory press.
7. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones 16 and Bartlett Learning.
8. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

## **BM 104** **Bacteriology & Virology** Total Marks 50, Credits 4

### **Unit 1: Cell Organization**

**No. of Hours: 12**

Cell size, shape and arrangement; glycocalyx; capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial 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 2: Bacteriological Techniques**

**No. of Hours: 4**

Concept of and isolation of Pure culture: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

### **Unit 3: Nutrition and Media**

**No. of Hours: 10**

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, acid-base indicator, enriched and enrichment media.

### **Unit 4. Bacterial Systematics**

**No. of Hours: 6**

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, Characters used in bacterial systematic: rRNA oligonucleotide sequencing, Signature sequences. Differences between eubacteria and archaeobacteria.

### **Unit 5. Nature and Properties of Viruses**

**No. of Hours: 12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses; Isolation, purification and cultivation of viruses; Viral taxonomy: Classification and nomenclature of different groups of viruses.

### **Unit 6. Viral multiplication in the Cell:**

**No. of Hours: 8**

Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda) Lytic and lysogenic cycle; Plant (TMV & Cauliflower Mosaic Virus), Human (Replication and Symptoms of: Adenovirus, Retrovirus, Hepatitis viruses, Influenza virus; Assembly, budding and maturation of HIV).

## Annexure VI

### Unit 7. Role of Viruses in Disease and its prevention

No. of Hours 8

Viruses as pathogens: Role of viruses in causing diseases; Prevention and control of viruses: Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination.

#### SUGGESTED READINGS:

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
12. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
13. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
14. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
15. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
16. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
17. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
18. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

## BM 192

### Practical II: Cell & Molecular Biology and Bacteriology & Virology

Total Marks 50, Credits 4

#### Unit I: Cell & Molecular Biology

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs.
3. Cytochemical staining of DNA – Feulgen.
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Study of different stages of Mitosis & Meiosis by permanent slides.
7. Study of different types of DNA and RNA using micrographs and model/schematic representations.
8. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent)
9. Estimation of RNA using colorimeter (orcinol reagent)
10. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

## Annexure VI

### Unit II: Bacteriology & Virology

1. Simple staining.
  3. Negative staining.
  4. Gram's staining.
  5. Acid fast staining-permanent slide only.
  6. Capsule staining.
  7. Endospore staining.
  2. Preparation of different media: Synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar, Endo agar.
  8. Isolation of pure cultures of bacteria by streaking method.
  10. Preservation of bacterial cultures by various techniques.
  11. Estimation of CFU count (serial dilution of soil and water sample) by spread plate method/pour plate method.
  12. Motility by hanging drop method.
  13. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B and retroviruses) using electron micrographs.
  14. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
  15. Study of the structure of important bacterial viruses ( $\phi$ X 174, T4,  $\lambda$ ) using electron micrograph.
  16. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique (plaque assay).
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## Semester III

### BM 201

### Microbial Physiology and Metabolism

Total Marks 50, Credits 4

#### **Unit 1 Microbial Growth and Effect of Environment on Microbial Growth:**

**No. of Hours: 12**

Definitions of growth, measurement of microbial growth, Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, Batch culture, Continuous culture, calculation of generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

#### **Unit 2 Nutrient uptake and Transport:**

**No. of Hours: 4**

Passive and facilitated diffusion; Primary and secondary active transport, concept of uniport, symport and antiport; Group translocation; Iron uptake

#### **Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration:**

**No. of Hours: 12**

Concept of aerobic respiration, anaerobic respiration and fermentation; Sugar degradation pathways and their energy yield: Glycogenolysis, Glycolysis, Pentose phosphate pathway, Entner-Doudoroff Pathway, and TCA cycle; Gluconeogenesis. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

#### **Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation: No. of Hours: 4**

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) and sulfate reduction. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

#### **Unit 5 Chemolithotrophic and Phototrophic Metabolism:**

**No. of Hours: 6**

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria.

#### **Unit 6 Nitrogen Metabolism - an overview:**

**No. of Hours: 6**

Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification, ANAMMOX, COMAMMOX.

#### **Unit 7. Amino Acid Metabolism**

**No. of Hours 8**

Concepts of Transamination, Deamination, Transmethylation and Decarboxylation; Biosynthesis of aspartate family of amino acids. Degradation of amino acids: Metabolic Fates of Amino Groups, Nitrogen Excretion and the Urea Cycle, Glucogenic and Ketogenic Amino Acids.

## Annexure VI

### Unit 8. Lipid Metabolism

**No of Hours 4**

Oxidation of Even-And Odd-Carbon Numbered, Saturated and Unsaturated Fatty Acids; Brief Idea of Fatty Acid Biosynthesis; Metabolism of Triglycerides and Phospholipids.

### Unit 9. Purine and Pyrimidine Metabolism

**No of Hours 4**

Synthesis of Purines and Pyrimidines (Elementary Concept); Microbial Reduction of Purines to Deoxy-Purines.

### SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingraham JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition,McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
7. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition, W.H. Freemanand Company,
8. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

## BM 203

### Microbial Genetics

Total Marks 50, Credits 4

#### Unit 1. Mendelian Principles:

**No. of Hours: 10**

Genotype, Phenotype;Monohybrid, Dihybrid cross;Mendel's Laws: Dominance, recessiveness,segregation, independent assortment, autosomal & sex linked inheritance;Deviation from Mendelian inheritance; Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics; Allelic interactions; Concept of Incomplete dominance and co-dominance, Epistasis, penetrance and expressivity.

#### Unit 2. Genome Organization, Mutations and Repair.

**No. of Hours: 18**

Experimental evidence for DNA as genetic material (Experiments of Griffith, Avery and MacLeod; Hershey and Chase); Experimental evidence for RNA as genetic material (TMV),Genome organization: *E. coli*, *Saccharomyces*, *Tetrahymena*. Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutatorgenes.Repair: Reversal of UV damage in prokaryotes: photoreactivation, base excision and nucleotide excision repair, post replicational repair, mismatch repair, SOS repair, error prone repair.

#### Unit 3. Plasmids:

**No. of Hours: 8**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids,yeast- 2 $\mu$ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmidamplification, Regulation of copy number, curing of plasmids.

#### Unit 4. Mechanisms of Genetic Exchange

**No. of Hours: 12**

Transformation - Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.

#### Unit 5. Phage Genetics

**No. of Hours: 4**

Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda

## Annexure VI

### Unit 6. Transposable elements

**No. of Hours: 8**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon; Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize(Ac/Ds); Uses of transposons and transposition.

#### **SUGGESTED READINGS:**

1. Larry Snyder, J. E. Peters, Tina M. Henkin, Wendy Champness (2013) Molecular Genetics of Bacteria, 4<sup>th</sup> Ed., ASM Press.
  2. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
  3. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
  4. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
  5. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
  6. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
  7. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
  8. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4<sup>th</sup> Edition, Cold Spring Harbour Laboratory press.
  9. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers
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## Semester IV

### BM 202 Bio-techniques and Bio-statistics

Total Marks 50, Credits 4

#### Unit 1. Bioenergetics

**No of Hours 6**

First and Second Laws of Thermodynamics; Definition of Gibb's Free Energy, Enthalpy, and Entropy; Mathematical Relationships Among Them; Standard Free Energy Change and Equilibrium Constant; Coupled Reactions And Additive Nature of Standard Free Energy Change; Energy Rich Compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP.

#### Unit 2. Microscopy: Principles and applications.

**No of Hours 8**

Principles and applications of - Light microscopy: brightfield and darkfield, Phase contrast microscopy, Fluorescence Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy); Micrometry.

#### Unit 3. Electromagnetic radiation and Spectrophotometry.

**No of Hours 8**

*Basic principles of electromagnetic radiation:* Energy, wavelength, wave numbers and frequency, review of electronic structure of molecules.

*UV-visible spectrophotometry:* Beer Lambert law, light absorption and its transmittance, factors affecting absorption properties of a chromophore, Principle and use of study of absorption spectra of biomolecules; structural analyses of DNA/ protein using absorption of UV light. Colorimetry and turbidometry

*Fluorescence spectroscopy:* Theory of fluorescence, static and dynamic quenching, resonance energy transfer, fluorescent probes in the study of protein and nucleic acids.

*Mass spectrometry (MALDI-TOF):* Physical basis and uses of MS in the analysis of proteins/ nucleic acids.

#### Unit 4. Radiation Biology.

**No of Hours 6**

Concept of radioisotopes, types of radioactive decay (gamma and beta emitter), half-life, detection and measurement of radioactivity: methods based upon ionization (GM counter), methods based upon excitation (scintillation counter). Autoradiography, radioisotopes diagnosis and radiotherapy. Effect of radiations (ionizing and non-ionizing) on living systems, precautions and safety measures in handling radioisotopes.

#### Unit 5. Chromatography.

**No. of Hours: 10**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography, Column chromatography: packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography; GLC, HPLC.

#### Unit 6. Electrophoresis.

**No. of Hours: 6**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gelelectrophoresis, Isoelectric focusing, 2D gel electrophoresis; Zymogram preparation; Principle and applications of Agarose gelelectrophoresis.

#### Unit 6. Hydrodynamic methods.

**No. of Hours: 8**

*Viscosity:* Methods of measurement of viscosity, specific and intrinsic viscosity, relationship between viscosity and molecular weight, measurement of viscoelasticity of DNA.

*Sedimentation:* Principle of centrifugation; Svedberg equation, RCF and sedimentation coefficient; relationship between RPM and RCF; differential and density gradient centrifugation, preparative and analytical ultracentrifugation techniques, fractionation of cellular components using centrifugation with examples.

*Flow Cytometry:* Basic principle of flow cytometry and cell sorting, detection strategies in flow cytometry.

#### Unit 8. Biostatistics.

**No of Hours 8**

Introduction to biostatistics & its use. Basic idea on variables, frequency distribution and sampling. Measures of central tendency: mean, median, mode. Measures of distributions: variance, range, quartile deviation. Standard deviation and standard error - problems and application. Student's t-test and Chi square test- problems and application. Correlation and Regression.

**SUGGESTED READINGS:**

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7<sup>th</sup>Ed., Cambridge University Press.
2. David Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 2<sup>nd</sup> Ed., W.H. Freeman and Company.
3. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5<sup>th</sup>Ed., W.H. Freeman and Company.
4. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9<sup>th</sup>Ed., McGraw Hill.
5. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
6. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
7. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5<sup>th</sup> Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
8. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.
9. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
10. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

**BM 292**

**Practical III: Microbial Physiology and Bio-techniques**

Total Marks 50, Credits 4

**Unit I. Microbial Physiology**

1. Study and plot the growth curve of *E. coli* by turbidometric method.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of *E. coli*.
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E. coli*.
6. Effect of salt on growth of *E. coli*.
7. Demonstration of anaerobic culture methods.
8. Isolation of chemolithotrophic bacteria from soil.
9. Demonstration of alcoholic fermentation
10. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

**Unit II. Bio-techniques**

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Study of structural changes of proteins at different pH/Temperature using UV spectrophotometry.
4. Determination of melting temperature of DNA.
5. Separation of mixtures by paper / thin layer chromatography.
6. Demonstration of column packing in any form of column chromatography.
7. Separation of protein mixtures by any form of chromatography.
8. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
9. Preparation of agarose gel and loading of sample.
10. Determination of  $\lambda_{max}$  for an unknown sample and calculation of extinction coefficient.
11. Study the effect of temperature on the viscosity of a macromolecule (Protein/DNA).
12. Separation of components of a given mixture using a laboratory scale centrifuge.

## Semester V

### BM 301 Recombinant DNA Technology Total Marks 50, Credits 4

#### Unit 1. Introduction to Genetic Engineering

Milestones in genetic engineering and biotechnology

**No. of Hours: 2**

#### Unit 2. Molecular Cloning- Tools and Strategies

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering; DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyltransferase, kinases and phosphatases, and DNA ligases. Cloning Vectors: Definition and Properties; Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs; Use of linkers and adaptors; Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.

**No. of Hours: 20**

#### Unit 3. Methods in Molecular Cloning

Isolation and purification of nucleic acid; Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, Agrobacterium mediated delivery. DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis.

**No. of Hours: 16**

#### Unit 4. DNA Amplification and DNA sequencing

PCR: Basics of PCR, RT-PCR, Real-Time PCR; Sanger's method of DNA Sequencing: traditional and automated sequencing; Primer walking and shotgun sequencing.

**No. of Hours: 10**

#### Unit 5. Construction and Screening of Genomic and cDNA libraries

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

**No. of Hours: 6**

#### Unit 6. Applications of Recombinant DNA Technology

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

**No. of Hours: 6**

#### SUGGESTED READINGS:

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

**BM 303**  
**Immunology**  
Total Marks 50, Credits 4

**Unit 1 Introduction**

**No. of Hours: 4**

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.

**Unit 2 Immune Cells and Organs**

**No. of Hours: 8**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

**Unit 3 Antigens**

**No. of Hours: 4**

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

**Unit 4 Antibodies**

**No. of Hours: 6**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

**Unit 5 Major Histocompatibility Complex**

**No. of Hours: 4**

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways).

**Unit 6 Complement System**

**No. of Hours: 4**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

**Unit 7 Generation of Immune Response**

**No. of Hours: 10**

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. Principle of vaccination.

**Unit 8 Immunological Disorders and Tumor Immunity**

**No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

**Unit 9 Immunological Techniques**

**No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.

**SUGGESTED READINGS:**

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

**BM 305**  
**Medical Microbiology**  
Total Marks 50, Credits 4

**Unit 1. Normal microflora of the human body and host pathogen interaction. No. of Hours: 8**

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

**Unit 2. Bacterial diseases No. of Hours: 18**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control-Respiratory Diseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis*. Gastrointestinal Diseases: *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*. Others: *Staphylococcus aureus*, *Clostridium tetani*, *Treponema pallidum*.

**Unit 3. Viral diseases No. of Hours: 14**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

**Unit 4. Protozoan diseases No. of Hours: 6**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Malaria, Kala-azar.

**Unit 5. Fungal diseases No. of Hours: 6**

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot); Systemic mycoses: Histoplasmosis; Opportunistic mycoses: Candidiasis.

**Unit 6. Antimicrobial agents: General characteristics and mode of action No. of Hours: 8**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

**SUGGESTED READINGS:**

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4<sup>th</sup> edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition



**BM391**

**Practical IV: Microbial Genetics and Recombinant DNA Technology**

Total Marks 50, Credits 4

**Unit I. Microbial Genetics**

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO<sub>2</sub>) and physical (UV) mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of Genomic DNA from *E. coli*.
5. Isolation of Plasmid DNA from *E. coli*.
6. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
7. Demonstration of Bacterial Conjugation.
8. Demonstration of bacterial transformation and transduction.
9. Demonstration of AMES test.

**Unit II. Recombinant DNA Technology**

1. Preparation of competent cells for transformation.
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
4. Ligation of DNA fragments.
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms.
7. Designing of primers for DNA amplification.
8. Amplification of DNA by PCR.
9. Demonstration of Southern blotting.

**BM393**

**Practical V: Immunology and Medical Microbiology**

Total Marks 50, Credits 4

**Unit I. Immunology**

1. Identification of human blood groups.
2. Perform Agglutination test.
3. Perform Total Leukocyte Count of the given blood sample.
4. Perform Differential Leukocyte Count of the given blood sample.
5. Separate serum from the blood sample (demonstration).
6. Perform immunodiffusion by Ouchterlony method / Radial Immunodiffusion method.
7. Perform DOT ELISA/Indirect ELISA.
8. Perform immunoelectrophoresis.

**Unit II. Medical Microbiology**

1. Identify bacteria (*E. coli*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMBAgar, Endo agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Antibiotic sensitivity test by agar-cup and paper disc methods of commonly used antibiotics.
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

## Semester VI

### BM 302 Industrial Microbiology Total Marks 50, Credits 4

#### Unit 1. Introduction to industrial microbiology

No. of Hours: 2

Brief history and developments in industrial microbiology

#### Unit 2. Isolation of industrially important microbial strains and fermentation media No. of Hours: 12

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

#### Unit 3. Types of fermentation processes, bio-reactors and measurement of fermentation parameters

No. of Hours: 14

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

#### Unit 4 Down-stream processing

No. of Hours: 6

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

#### Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)

No. of Hours: 22

Citric acid, acetic acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase), Wine, beer, champagne.

#### Unit 6 Enzyme immobilization

No. of Hours: 4

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

#### SUGGESTED READINGS:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2<sup>nd</sup> edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

**BM 304**  
**Food and Dairy Microbiology**  
Total Marks 50, Credits 4

**Unit 1. Foods as a substrate for microorganisms**

**No. of Hours: 8**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

**Unit 2. Microbial spoilage of various foods**

**No. of Hours: 10**

Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

**Unit 3. Principles and methods of food preservation**

**No. of Hours: 10**

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, SO<sub>2</sub>, nitrite and nitrates, ethyleneoxide, antibiotics and bacteriocins.

**Unit 4. Fermented foods**

**No. of Hours: 10**

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

**Unit 5. Food borne diseases (causative agents, foods involved, symptoms and preventive measures)**

**No. of Hours: 10**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins (*Aspergillus flavus*); Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*.

**Unit 6. Food sanitation and control**

**No. of Hours: 4**

HACCP, Indices of food sanitary quality and sanitizers.

**Unit 7. Detection of Pathogenic Microorganisms in Food & Water**

**No. of Hours 8**

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay).

**SUGGESTED READINGS:**

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7<sup>th</sup> edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9<sup>th</sup> edition. Pearson Education.

**BM 306**  
**Environmental Microbiology**  
Total Marks 50, Credits 4

**Unit 1. Microorganisms and their Habitats**

**No. of Hours: 14**

Structure and function of ecosystems: Terrestrial Environment: Soil profile and soil microflora; Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter.

**Unit 2. Microbial Interactions**

**No. of Hours: 12**

Microbe-microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.

**Unit 3. Biogeochemical Cycling**

**No. of Hours: 12**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese.

**Unit 4 Waste Management**

**No. of Hours: 12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

**Unit 5 Microbial Bioremediation**

**No. of Hours: 4**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.

**Unit 6 Water Potability**

**No. of Hours: 6**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

**SUGGESTED READINGS:**

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4<sup>th</sup> edition Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition Pearson/Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2<sup>nd</sup> edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**BM 308**  
**Bioinformatics, Biosafety and IPR**  
Total Marks 50, Credits 4

**Bioinformatics**

**Unit 1. Introduction to Bioinformatics and Biological Databases**

**No. of Hours 6**

Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB. Human Genome Project.

**Unit 2. Sequence Alignments, Phylogeny and Phylogenetic trees**

**No. of Hours 10**

Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction-UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood.

**Unit 3. Protein Structure Predictions**

**No. of Hours 8**

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling; Structural Classes, Motifs, Folds and Domains; Protein structure prediction in presence and absence of structure template; Protein structure and rational drug design.

**Biosafety and IPR**

**Unit 1**

**No of Hours: 4**

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

**Unit 2**

**No of Hours: 6**

Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

**Unit 3**

**No of Hours: 2**

AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

**Unit 4**

**No of Hours: 8**

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

**Unit 5**

**No of Hours: 8**

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

**Unit 6**

**No of Hours: 8**

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

**Suggested Readings:**

1. Bioinformatics: Sequence and Genome analysis, 2nd edition (2004), David W. Mount, ColdSpring Harbour Laboratory Press. ISBN-13: 978-0879697129.
2. Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition (2004), AndreasD. Baxevanis and B.F. Francis Ouellette, John Wiley and Sons. ISBN-13: 978-0471478782.

## Annexure VI

3. Introduction to Medicinal Chemistry, 4th edition (2009), Graham I. Patrick, Oxford University Press
4. The Process of New Drug Discovery and Development, 2nd edition (2006), C.G. Smith and J.T.O'Donnell, Informa Healthcare, ISBN-13: 978-0849327797.
5. Cheminformatics (2003), J. Gasteiger, Thomas Engel; Wiley-VCH. ISBN: 9783527618279.
6. Molecular modeling - Principles and Applications, 2nd edition (2003), A. R. Leach, Pearson Education Limited, UK. ISBN 13: 9780582382107.
7. Cheminformatics in Drug Discovery (2006), edited by. T.I. Opera; Wiley Publishers, ISBN: 9783527604203.
8. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
9. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

### **BM392**

#### **Practical VI: Applied Microbiology**

Total Marks 50, Credits 4

##### **Unit I. Food, Industrial and Environmental Microbiology**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.
7. Study different parts of fermenter
8. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
9. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
10. Isolation and enumeration of microbes (bacteria & fungi) from rhizospheric soil and rhizoplane.
11. Assessment of microbiological quality of water (Presumptive test, Confirmatory test, Completed test for coliform; IMVIC reactions)
12. Determination of BOD of waste water sample.
13. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, Amylase, phosphatase) in soil.
14. Isolation of Rhizobium from root nodules.

### **BM394**

#### **Practical VII: Bioinformatics and Project Work**

Total Marks 50, Credits 4

##### **Unit I. Bioinformatics**

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene.
8. Filing primary applications for patents.
9. Study of steps of a patenting process.
10. A case study.

## Annexure VI

### **Unit II. Project Work**

A student has to do a project work / review work in a topic given by his/her supervisor (to be decided by lottery amongst all the teachers present for that Semester) and submit the report/review within a stipulated time. During examination the work has to be presented before an evaluation team (one external member may be invited) and the student will be credited based on the quality of the report and presentation.

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## Department of Biological Sciences, Aliah University, Newtown, Kolkata

### Draft Syllabus for the Microbiology Subsidiary Papers

#### Overall Curriculum

Semester	Theory			Practical		
	Course Code	Course Title	Marks/Credits	Course Code	Course Title	Marks/Credits
I	BM131	General Microbiology I	50/4			
II	BM132	General Microbiology II	50/4			
III	BM231	Industrial and Food Microbiology	50/4	BM261	<b>Practical I:</b> General Microbiology	50/4
IV	BM232	Environmental and Medical Microbiology	50/4	BM 262	<b>Practical II:</b> Applied Microbiology	50/4
<b>Total</b>			<b>200/16</b>			<b>100/8</b>
<b>Grand Total</b>	<b>300 Marks / 24 Credits</b>					



## Semester I

### BM 131 General Microbiology – I Total Marks 50, Credits 4

#### Unit 1. History of Development of Microbiology

**No. of Hours: 8**

Spontaneous generation (abiogenesis), Biogenesis, Germ theory of disease; Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Koch's Postulates. An overview of Scope of Microbiology.

#### Unit 2. General characteristics of different groups

**No of hours 18**

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.

#### Unit 3. Systems of classification and Bacterial systematics

**No of hours 12**

Aim and principles of classification; Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. Systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, Characters used in bacterial systematics: rRNA oligonucleotide sequencing, Signature sequences. Differences between eubacteria and archaebacteria.

#### Unit 4. Concept and Methods of Sterilization (Control of microbial growth)

**No. of Hours 8**

Physical methods of microbial control: heat (moist heat and dry heat) low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Tyndallization. Chemical methods of microbial control: disinfectants, types and mode of action.

#### Unit 5. Nutrition and Media

**No. of Hours: 6**

Nutritional requirements in bacteria and nutritional categories (Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.). Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, acid-base indicator, enriched and enrichment media.

#### Unit 6. Basics of Staining

**No of hours 4**

Classification/types of stains; Acidic and Basic dyes, Simple and differential staining, negative staining. Mordants and Chromophores.

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## Semester II

### BM 132 General Microbiology – II Total Marks 50, Credits 4

#### Unit 1. Cellular Organization

**No. of Hours: 12**

Cell size, shape and arrangement; glycocalyx; capsule, flagella, endoflagella, fimbriae and pili. 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

## Annexure VI

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 2. Bacteriological Techniques**

**No. of Hours: 4**

Concept of and isolation of Pure culture: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

### **Unit 3. Microbial Growth and Effect of Environment on Microbial Growth:**

**No. of Hours: 10**

Definitions of growth, measurement of microbial growth, Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, Batch culture, Continuous culture, calculation of generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

### **Unit 4. Mechanisms of Genetic Exchange**

**No. of Hours: 12**

Transformation – Discovery and mechanism, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.

### **Unit 5. Nature and Properties of Viruses**

**No. of Hours: 10**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses; Isolation, purification and cultivation of viruses; Viral taxonomy: Classification and nomenclature of different groups of viruses.

### **Unit 6. Viral multiplication in the Cell:**

**No. of Hours: 8**

Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Genetic basis of lytic versus lysogenic switch of phage lambda; Plant (TMV & Cauliflower Mosaic Virus), Human (Replication and Symptoms of: Adenovirus, Retrovirus, Hepatitis viruses, Influenza virus; Assembly, budding and maturation of HIV).

### **Unit 7. Role of Viruses in Disease and its prevention**

**No. of Hours 4**

Viruses as pathogens: Role of viruses in causing diseases; Prevention and control of viruses: Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination.

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## **Semester III**

### **BM 231**

### **Industrial and Food Microbiology**

Total Marks 50, Credits 4

### **Unit 1 Introduction to Industrial microbiology**

**No. of Hours: 10**

Brief history and developments in industrial microbiology; Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous; Types of fermenters – laboratory, pilot-scale and production fermenters Components of a typical continuously stirred tank bioreactor.

### **Unit 2. Isolation of Industrial Strains and Fermentation Medium**

**No. of Hours: 6**

## Annexure VI

Primary and secondary screening; Strain improvement; Preservation and maintenance of industrial strains; Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract.

### Unit 3. Microbial fermentation processes

**No. of Hours: 14**

Downstream processing - Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying. Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases. Production of beverages - Wine, beer, champagne.

### Unit 4. Food as a substrate for microbial growth

**No. of Hours: 8**

Intrinsic and extrinsic parameters that affect microbial growth in food; Microbial spoilage of food - milk, egg, bread and canned foods.

### Unit 5. Principles and methods of food preservation and food sanitation

**No. of Hours: 10**

Physical methods - temperature (low, high, canning, drying), irradiation, microwave processing and aseptic packaging. Chemical methods - salt, sugar, organic acids, SO<sub>2</sub>, nitrite and nitrates, ethyleneoxide, antibiotics and bacteriocins. Food sanitation and control – HACCP.

### Unit 6 Dairy products, probiotics and Food-borne Diseases

**No. of Hours: 12**

Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese. Probiotics definition, examples and benefits. Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*. Food infection by *Salmonella* and *E.coli*.

## BM 261

### Practical I: General Microbiology

Total Marks 50, Credits 4

1. Microbiology Good Laboratory Practices and Biosafety.
  2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
  3. Preparation of culture media (Nutrient broth/agar, Luria-bertini broth/agar) for bacterial cultivation and their sterilization using Autoclave and assessment for sterility.
  4. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air and water.
  5. Study of any one fungi, algae and protozoa using temporary/permanent mounts.
  6. Simple staining, Negative staining, Gram's staining, Capsule staining, Endospore staining.
  7. Preparation of different media: Synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar or Endo agar.
  8. Isolation of pure cultures of bacteria by streaking method.
  9. Preservation of bacterial cultures by various techniques (slant, stab, glycerol stock).
  10. Estimation of CFU count (serial dilution of soil and water sample) by spread plate method/pour plate method.
  11. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B and retroviruses) using electron micrographs.
  12. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
  13. Study of the structure of important bacterial viruses ( $\phi$ X 174, T4,  $\lambda$ ) using electron micrograph.
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## Semester IV

### BM 232

### Environmental and Medical Microbiology

Total Marks 50, Credits 4

#### Environmental Microbiology:

##### Unit 1. Microbial Habitats and their Interactions

**No. of Hours: 12**

Soil microflora; Microflora of fresh water and marine habitats: Potability of water (presumptive test/MPN test, confirmed and completed tests for coliforms); Aeromicroflora. Microbes in/on human body & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.

##### Unit 2. Biogeochemical Cycling

**No. of Hours: 12**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle.

##### Unit 3. Waste Management and Microbial Bioremediation

**No. of Hours: 8**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter.

#### Medical Microbiology:

##### Unit 4. Normal microflora of the human body and host pathogen interaction. No. of Hours: 8

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiological effects of LPS

##### Unit 5. Bacterial diseases

**No. of Hours: 6**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control - Tuberculosis, Cholera, Tetanus,

##### Unit 6. Viral diseases

**No. of Hours: 4**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control - Polio, AIDS.

##### Unit 7. Protozoan diseases

**No. of Hours: 2**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control - Malaria.

##### Unit 8. Fungal diseases

**No. of Hours: 2**

Brief description of various types of mycoses. The following disease in detail with respect to transmission, symptoms and prevention - Candidiasis.

##### Unit 9. Antimicrobial agents: General characteristics and mode of action

**No. of Hours: 6**

Antibacterial agents: modes of action of - Inhibitors of nucleic acid synthesis; Inhibitors of cell wall synthesis; Inhibitors of cell membrane function; Inhibitors of protein synthesis; Inhibitors of metabolism. Antifungal agents:

## Annexure VI

Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

### **BM 262** **Practical II: Applied Microbiology** Total Marks 50, Credits 4

1. MBRT of milk samples and their standard plate count.
  2. Isolation of any food borne bacteria from food products.
  3. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
  4. Isolation of spoilage microorganisms from bread.
  5. Study different parts of fermenter
  6. Isolation and enumeration of microbes (bacteria & fungi) from rhizospheric soil and rhizoplane.
  7. Assessment of microbiological quality of water (Presumptive test, Confirmatory test, Completed test for coliform; IMVIC reactions)
  8. Determination of BOD of waste water sample.
  9. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, Amylase, phosphatase) in soil.  
Study of bacterial flora of skin by swab method
  10. Perform antibacterial sensitivity by Kirby-Bauer method
  11. Antibiotic sensitivity test by agar-cup and paper disc methods of commonly used antibiotics.
  12. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
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