

# **The University of Burdwan**



**Syllabus for B.Sc.(Hons.)**

**in**

**Microbiology**

**Under Choice Based Credit System**

**w.e.f. 2017-2018 onward**

**UG Course in Microbiology under CBCS Pattern, The University of Burdwan**

Course Code	Course Title	Credit	Marks				No. of Hours	
			I.A. (Th +Prc)	ESE		Total	Lec/ week	Prc/ week
				Th	Prc			
CC-1	Introduction to Microbiology and Microbial Diversity (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-2	Bacteriology (Theory & Practical)	6	10+5=15	40	20	75	4	4
GE-1	Introduction and Scope of Microbiology OR Bacteriology & Virology (Theory & Practical)	6	10+5=15	40	20	75	4	4
AECC-1	ENVS	4				100	4	
<b>Total in Semester I</b>		22	45	120	60	325		
CC-3	Biochemistry (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-4	Virology (Theory & Practical)	6	10+5=15	40	20	75	4	4
GE-2	Microbial Metabolism OR Microbes in Environment (Theory & Practical)	6	10+5=15	40	20	75	4	4
AECC-2	English Communication/MIL	2				50	2	4
<b>Total in Semester II</b>		20	45	120	60	275		
CC-5	Microbial Physiology & Metabolism (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-6	Cell Biology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-7	Molecular Biology (Theory & Practical)	6	10+5=15	40	20	75	4	4
GE-3	Medical Microbiology & Immunology OR Industrial & Food Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
SEC-1	Microbiological Analysis of Air and Water OR Microbial Diagnosis in Health Clinics	2	10	40		50	2	
<b>Total in Semester III</b>		26	70	280		350		
CC-8	Microbial Genetics (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-9	Environmental Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-10	Food and Dairy Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4

GE-4	Genetic Engineering & Biotechnology OR Microbial Genetics & Molecular Biology (Theory & Practical)	6	10+5=15	40	20	75	4	4
SEC-2	Bio-fertilizers and Bio-pesticides OR Food Fermentation Techniques	2	10	40		50	2	
<b>Total in Semester IV</b>		26	70	280		350		
CC-11	Industrial Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-12	Immunology (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-1	Microbes in Sustainable Agriculture and Development OR Bioinformatics (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-2	Instrumentation and Biotechniques OR Microbial Biotechnology (Theory & Practical)	6	10+5=15	40	20	75	4	4
<b>Total in Semester V</b>		24	60	160	80	300		
CC-13	Medical Microbiology (Theory & Practical)	6	10+5=15	40	20	75	4	4
CC-14	Recombinant DNA Technology (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-3	Advances in Microbiology OR Term Paper & Its Power Point Presentation (Theory & Practical)	6	10+5=15	40	20	75	4	4
DSE-4	Bio-safety and Intellectual Property Rights OR Plant Pathology (Theory & Practical)	6	10+5=15	40	20	75	4	4
<b>Total in Semester VI</b>		24	60	160	80	300		

**MCBH = Subject Code, CC= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GE= Generic Elective, DSE= Discipline Specific Elective IA= Internal Assessment, ESE= End-Semester Examination, Lec.=Lecture, Tu.= Tutorial, Th= Theory and Prc.=Practical**

**Option each from GE, DSE and SEC may be selected only once by a candidate.**

## Core Course CC1 (Theory Paper)

### INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

4 Credits

#### **Unit 1: History and Development of Microbiology:**

Theory of Spontaneous generation, Germ theory of disease. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich Martinus W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology. An overview of the Scope of Microbiology

#### **Unit 2: Diversity of Microbial world:**

Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese, General characteristics and representative members of different groups: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)  
Acellular entity (Viruses, Viroids, Virusoids, Satellite viruses, Prions)

#### **Unit 3 Microscopy**

Principle and application of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope and Scanning Electron Microscope.

#### **Unit 4 Phycology**

General characteristics of algae including occurrence (habitat), thallus organization, cell ultra structure, pigments, flagella, eyespot, food reserves (reserve foods) and reproduction in Chlorophyta and Xanthophyta. Economic Importance of algae.

#### **Unit 5 Mycology**

General characteristics of fungi including habit, habitat, nutritional requirements, thallus organization and aggregation, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi

#### **Unit 6 Protozoa**

Life Cycle of *Amoeba*, *Paramecium*, *Plasmodium*. Economic importance of Protozoa.

## Reference Books

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. WM. T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

## Core Course CC1 (Practical Paper):

### INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

#### 2 Credits

1. Microbiology Laboratory Management and Bio-safety
2. To study the principle and applications of instruments (autoclave, incubator, hot air oven, centrifugation, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth and Nutrient 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 filtration
7. Isolation and enumeration of bacteria from air, water and soil.
8. Study of *Rhizopus*, *Penicillium* and *Aspergillus* from permanent slides.
9. Study of *Spirogyra* and *Chlamydomonas* from permanent slides.

10. Study of *Paramecium* and *Plasmodium* from permanent slides.

## Core Course CC2 (Theory Paper)

### BACTERIOLOGY

4 Credits

#### Unit 1: Cell Organization

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

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.

#### Unit 3: Nutrition

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 media

#### Unit 4: Control of Microorganisms

Physical methods of microbial control: heat, low temperature, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: types and mode of action.

#### Unit 5: Growth & Reproduction in Bacteria

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

#### Unit 6: Bacterial Systematics

Aim and principles of classification, taxonomy, concept of species, taxa, strain; Characters used in bacterial systematic.

#### Unit 7: Important Archaeal & Bacterial Groups

**Archaea:** Different physiological groups, suitable example and economic importance.

**Bacteria:** General characteristics & economic importance with suitable example of the following groups:

**Gram Negative:** Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Delta

proteobacteria, Epsilon proteobacteria, Zeta proteobacteria.

**Gram Positive:** Low G+ C (Firmicutes), High G+C (Actinobacteria).

**Cyanobacteria**

**Reference Books:**

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.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

**Core Course CC2 (Practical Paper):**

**BACTERIOLOGY**

**2 Credits**

1. Preparation of different media: synthetic media (BG-11), Complex media- Tryptic soy agar, Differential and Selective media (McConkey agar, EMB agar).
2. Simple staining.
3. Negative staining.
4. Gram's staining.
5. Acid fast staining-permanent slide only.
6. Endospore staining.
7. Isolation of pure cultures of bacteria by streaking method.
8. Preservation of bacterial cultures (slant / stab).

9. Estimation of CFU count by spread plate method/pour plate method.

10. Motility by hanging drop method.

**Core Course CC3 (Theory Paper)**  
**BIOCHEMISTRY**

**4 Credits**

**Unit1: Bioenergetics**

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy; mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate and ATP.

**Unit2: Carbohydrates**

General properties and classification of carbohydrates, families of monosaccharides: structural concept of aldoses and ketoses, trioses, tetroses, pentoses, and hexoses (glucose and fructose). Stereo isomerism of monosaccharides, epimers and anomers of glucose, Mutarotation, optical isomerism. Furanose and pyranose forms of glucose and fructose, sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides: concept of reducing and non-reducing sugars, occurrence; Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose and peptidoglycan.

**Unit3: Lipids**

Fatty acids: definition, types, structures and functions, essential fatty acids. Lipid: definition, nomenclature and classification (triacyl glycerols, phosphoglycerides, phosphatidylethanolamine, phosphatidylcholine, sphingosine with functions.

**Unit4: Proteins**

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. 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.

**Unit5: Enzymes**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, specificity, enzyme kinetics, Michaelis-Menten equation and their transformations, Km and allosteric mechanism, Lock and key hypothesis, and Induced Fit hypothesis. Definitions – enzyme unit, specific activity and turnover



number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature, substrate concentration, enzyme concentration, time on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts, uncompetitive.

#### **Unit 6: Vitamins**

Classification and importance.

#### **Unit 7: Vitamins & Nucleic Acids**

Purine, pyrimidine bases, nucleoside, nucleotide-structure, properties. Types of DNA and RNA.

#### **Reference Books:**

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
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 & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill.
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

#### **Core Course CC3 (Practical Paper)**

##### **BIOCHEMISTRY**

**2 Credits**

1. Concept of pH and buffers, preparation of buffers – phosphate and acetate buffer.
2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars (DNS method)
3. Qualitative/Quantitative tests for proteins (Lowry method), amino acids (Ninhydrine), DNA(DPA) and RNA(Orcinol).
4. Qualitative/Quantitative assay of amylase.
5. Study the effect of temperature and pH on enzyme activity (amylase).
6. Estimation of Ascorbic acid.

#### **Core Course CC4 (Theory Paper)**

##### **VIROLOGY**

**4 Credits**

### **Unit 1: Nature & Properties of Viruses**

Introduction: Discovery of viruses, nature and general properties.

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses

Isolation, purification and cultivation of viruses

Viral taxonomy: Baltimore Classification

### **Unit 2: Bacteriophages**

Diversity, classification, lytic and lysogenic cycle of lambda phage

### **Unit 3: Viral Transmissions, salient features of Viral Nucleic acids & Reproduction**

Mode of viral transmission

Structure, Nucleic acid, Replication and Symptoms of : Adenovirus, Retrovirus, Hepatitis B virus, Influenza virus

Assembly, budding and maturation of HIV

### **Unit 4: Viruses & Cancer**

Introduction to oncogenic viruses

Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

### **Unit 5: Prevention & Control of Viral Diseases**

Antiviral compounds and their mode of action

Interferon and their mode of action

General principles of viral vaccination

### **Unit 6: Applications of Virology**

Use of viral vectors in cloning and expression and Gene therapy.

### **Reference Books:**

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc
3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
4. 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.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

### **Core Course CC4 (Practical Paper)**

#### **VIROLOGY**

**2 Credits**

1. Study of TMV infection on Tomato plant induced by TMV infected tobacco extract.
2. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
3. Study of one step phage growth curve using isolated bacteriophages.
4. Isolation of Bacteriophage DNA and study of its HindIII digestion pattern.
5. Report writing: Educational tour to Institute/ Industry.

### **GENERIC ELECTIVE**

#### **Generic Elective GE1:**

**Introduction & Scope of Microbiology (Theory Paper)****4 Credits****Unit 1: History & Development of Microbiology**

History and Development of microbiology

Theory of Spontaneous generation, Germ theory of disease

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner in the field of Microbiology

Scope of Microbiology

**Unit 2: Diversity of Microorganisms**

Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woese

Basic idea of cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)

Basic idea of acellular microorganisms (Viruses, Viroids, Prions)

**Unit 3: Microscopy**

Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope, Scanning Electron Microscope

**Unit 4: Sterilization**

Moist Heat, Dry Heat, Hot Air Oven, Tyndallization, Filtration

**Unit 5: Microbes in Human Health & Environment**Transmission, symptoms and treatment of Respiratory tract disease (*Mycobacterium tuberculosis*), Gastrointestinal disease (*Helicobacter pylori*), Cutaneous disease (*Candida albicans*)

Fundamental concept of Innate and Adaptive immunity; Definitions of Antigen, Hapten, Antibody, APC, ADCC.

Role of Microbes in Bioremediation, Biodegradation, Biopesticides and Biofertilizers

**Unit 6: Food & Dairy microbiology**

Prebiotics and Probiotics

Microorganisms in food fermentations (dairy and non dairy based fermented food products)

Pasteurization

Microorganisms in spoilage of vegetables and meat.

**Reference Books**

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.

### **Introduction & Scope of Microbiology**

**(Practical Paper)**

**2 Credits**

1. Microbiology Laboratory Management and Bio-safety
2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth and Nutrient 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 filtration
7. Isolation and enumeration of bacteria from air
8. Isolation of spoilage microorganism from rotten bread

**OR**

### **Bacteriology and Virology**

**(Theory Paper)**

**4 Credits**

#### **Unit 1 Cell organization**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram-positive and gram-negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

#### **Unit 2 Bacterial growth and control**

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media

Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria

Growth: Binary fission, phases of growth

### **Unit 3 Bacterial Systematics and Taxonomy**

Taxonomy, nomenclature, systematics, types of classifications

Morphology, ecological significance and economic importance of the following groups:

Archaea: methanogens, thermophiles and halophiles

Eubacteria: Gram negative and Gram positive Gram negative:

Non-proteobacteria– *Deinococcus*, *Chlamydiae*, Spirochetes

Alpha proteobacteria- *Rickettsia*, *Rhizobium*, *Agrobacterium*

Gamma proteobacteria –*Escherichia*,*Shigella*,*Pseudomonas*

Gram positive: Low G+C: *Mycoplasma*, *Bacillus*, *Clostridium*, *Staphylococcus*

High G+C: *Streptomyces*, *Frankia*

### **Unit 4 Introduction to Viruses**

Properties of viruses; general nature and important features

Subviral particles; viroids, prions and their importance

Isolation and cultivation of viruses

### **Unit 5 Structure, and multiplication of viruses**

Morphological characters: Capsid symmetry and different shapes of viruses with examples Viral

multiplication in the Cell: Lytic and lysogenic cycle

Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses)

### **Unit 6 Role of Viruses in Disease and its prevention**

Viruses as pathogens: Role of viruses in causing diseases

Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

## **SUGGESTED READING**

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms. 14<sup>th</sup> edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5<sup>th</sup> edition. McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Control. 2<sup>nd</sup> edition. ASM Press
6. Shors Teri (2013) Understanding Viruses 2<sup>nd</sup> edition Jones and Bartlett Learning Burlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9<sup>th</sup> edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9<sup>th</sup> edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK

## **Bacteriology and Virology**

### **(Practical Paper)**

**2 Credits**

1. Preparation of different media: Nutrient agar, Nutrient broth.
2. To perform simple staining and Gram's staining of the bacterial smear.
3. To perform spore staining.
4. Isolation of pure cultures of bacteria by streaking method.
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate.
6. Study of the methods of isolation and propagation of plant viruses.
7. Study of cytopathic effects of viruses using photographs

**Generic Elective GE2:**

**Microbial Metabolism**

**OR Microbes in Environments**

**Microbial Metabolism (Theory Paper)**

**4 Credits**

**Unit 1: Microbial Growth & Effect of Environment on Microbial Growth**

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate

Temperature and temperature ranges of growth; pH and pH ranges of growth

Effect of oxygen concentration on growth

Nutritional categories of microorganisms (only definition and example)

**Unit 2: Nutrient Uptake & Transport**

Active, Passive and facilitated diffusion

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

Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle. Electron transport chain: components of respiratory chain, electron transport phosphorylation.

**Unit 4: Chemoheterotrophic Metabolism: Anaerobic Respiration & Fermentation**

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways).

**Unit 5: Chemolithotrophic & Phototrophic Metabolism**

Introduction to aerobic and anaerobic chemolithotrophy with example. Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria.

**Unit 6: Nitrogen Metabolism: An overview**

Introduction to biological nitrogen fixation

Ammonia assimilation

Assimilatory nitrate reduction



**Reference Books:**

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

**Microbial Metabolism (Practical Paper)****2 Credits**

1. Study of growth of *E. coli* by turbidometric method.
2. Effect of temperature on growth of *E. coli*
3. Effect of pH on growth of *E. coli*
4. Effect of salt on growth of *E. coli*
5. Demonstration of alcoholic fermentation
6. Demonstration of the thermal death time of *E. coli*.

**OR****Microbes in Environments (Theory Paper)****4 Credits****Unit 1: Microorganisms and their habitats**

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) &amp; animal (ruminants) body.

Extreme Habitats: Extremophiles: Microbes thriving at high &amp; low temperatures, pH, high hydrostatic &amp; osmotic pressures, salinity, &amp; low nutrient levels.

**Unit 2: Microbial Interactions**

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**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses.

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.

### **Unit 4: Waste Management**

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**

Principles and degradation of common pesticides, hydrocarbons (oil spills).

### **Unit 6: Water Potability**

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.

### **Reference Books**

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th 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 Hedeilberg
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*. 2nd 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.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). *Prescott's Microbiology*. 9th edition.

**Microbes in Environments (Practical Paper)**

**2 Credits**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water by filter disc method.
5. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase, urease) in soil.
6. Isolation of *Rhizobium* from root nodules.