

**CBCS SYLLABUS**  
**FOR**  
**THREE YEARS UNDER-GRADUATE COURSE**  
**IN**  
**MICROBIOLOGY (HONOURS)**  
*(w.e.f. 2017)*



**BANKURA UNIVERSITY**  
**BANKURA**  
**WEST BENGAL**  
**PIN 722155**



## 1. INTRODUCTION

The syllabus for Microbiology at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Microbiology.

The ultimate goal of the syllabus is that the students at the end are able to secure a job. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

It is essential that Microbiology students select their general electives courses Chemistry as compulsory and any one from the branch of Life Sciences disciplines.

While the syllabus is in compliance with UGC model curriculum, it is necessary that Microbiology students should learn “Bioinformatics, Microbes in Sustainable Agriculture and Development & Instrumentation and Biotechniques” as one of the core courses rather than as elective while. Course on “Concept of Genetics” has been moved to electives.

Also, it is recommended that the Project Work and Industrial Tour is compulsory for all the students as per their respective semester curriculum.



## 2. Scheme for CBCS Curriculum

### 2.1 Credit Distribution across Courses

			<b>Credits</b>
<b>Course Type</b>	<b>Total Papers</b>	<b>Theory + Practical</b>	<b>Theory*</b>
<b>Core Courses</b>	14	14*4 =56 14*2 =28	14*5 =70 14*1=14
<b>Discipline Specific Electives</b>	4	4*4=16 4*2=8	4*5=20 4*1=4
<b>Generic Electives</b>	4	4*4=16 4*2=8	4*5=20 4*1=4
<b>Ability Enhancement Language Courses</b>	2	2*2=4	2*2=4
<b>Skill Enhancement Courses</b>	2	2*2=4	2*2=4
<b>Totals</b>	<b>26</b>	<b>140</b>	<b>140</b>

\*Tutorials of 1 Credit will be conducted in case there is no practical component

Note:

- Microbiology students will be encouraged to take at least one Chemistry course as General Elective along with others from any branch of Life Science
- The DSE, SE courses may be made compulsory



## 2.2 Scheme for CBCS Curriculum

SEMESTER	COURSE	COURSE DETAIL	CREDITS
I	Ability Enhancement Compulsory Course – I	English communication / Environmental Science	2
	Core course – I	Introduction to Microbiology and Microbial Diversity	4
	Core course – I Practical	Introduction to Microbiology and Microbial Diversity	2
	Core course – II	Bacteriology	4
	Core course – II Practical	Bacteriology	2
	Genetic Elective – 1	Introduction and Scope of Microbiology	4
	Generic Elective – 1 Practical	Introduction and Scope of Microbiology	2
II	Ability Enhancement Compulsory Course – II	English communication / Environmental Science	2
	Core course – III	Biochemistry	4
	Core course – III Practical	Biochemistry	2
	Core course – IV	Virology	4
	Core course – IV Practical	Virology	2
	Generic Elective – 2	Bacteriology and Virology	4
	Generic Elective – 2 Practical	Bacteriology and Virology	2
III	Core course – V	Microbial Physiology and Metabolism	4
	Core course – V Practical	Microbial Physiology and Metabolism	2
	Core course – VI	Cell Biology	4
	Core course – VI Practical	Cell Biology	2
	Core course – VII	Molecular Biology	4
	Core course – VII Practical	Molecular Biology	2
	Skill Enhancement Course – 1	Microbiological Analysis of Air and Water	2
	Generic Elective – 3	Microbial Metabolism	4
	Generic Elective – 3 Practical	Microbial Metabolism	2
IV	Core course – VIII	Microbial Genetics	4
	Core course – VIII Practical	Microbial Genetics	2
	Core course – IX	Environmental Microbiology	4
	Core course – IX Practical	Environmental Microbiology	2
	Core course – X	Food and Dairy Microbiology	4
	Core course – X Practical	Food and Dairy Microbiology	2
	Skill Enhancement Course-2	Microbial Diagnosis in Health Clinics	2



	Generic Elective – 4	Medical Microbiology and Immunology	4
	Generic Elective – 4 Practical	Medical Microbiology and Immunology	2
V	Core course – XI	Industrial Microbiology	4
	Core course – XI Practical	Industrial Microbiology	2
	Core course – XII	Immunology	4
	Core course – XII Practical	Immunology	2
	Discipline Specific Elective – 1	Bioinformatics	4
	Discipline Specific Elective – 1 Practical	Bioinformatics	2
	Discipline Specific Elective – 2	Dissertation Work with Seminar	6
VI	Core course – XIII	Medical Microbiology	4
	Core course – XIII Practical	Medical Microbiology	2
	Core course – XIV	Recombinant DNA Technology	4
	Core course – XIV Practical	Recombinant DNA Technology	2
	Discipline Specific Elective – 3	Microbes in Sustainable Agriculture and Development	4
	Discipline Specific Elective – 3 Practical	Microbes in Sustainable Agriculture and Development	2
	Discipline Specific Elective – 4	Instrumentation and Biotechniques	4
	Discipline Specific Elective – 4 Practical	Instrumentation and Biotechniques	2

### 2.3 Choices for Discipline Specific Electives

<b>DSE-1</b>	Bioinformatics
<b>DSE-2</b>	Dissertation Work with Seminar
<b>DSE-3</b>	Microbes in Sustainable Agriculture and Development
<b>DSE-4</b>	Instrumentation and Biotechniques

### 2.4 Choices for Skill Enhancement Courses

<b>SE-1</b>	Microbiological Analysis of Air and Water
<b>SE-2</b>	Microbial Diagnosis in Health Clinics



### 3. Core T1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

<b>INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY</b>	
	<b>4 CREDITS</b>
<b>Unit 1 History and Development of Microbiology</b>	
<p>History and Development of microbiology</p> <p>Theory of Spontaneous generation, Germ theory of disease</p> <p>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</p> <p>An overview of the Scope of Microbiology</p>	
<b>Unit 2 Diversity of Microbial World</b>	
<p>Systems of classification:</p> <p>Systems of classification : Basic idea about Haeckel and Whittaker's kingdom concept and domain concept of Carl Woese</p> <p>General characteristics and representative members of different groups:</p> <p>Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)</p> <p>Acellular microorganisms (Viruses, Viroids, Prions)</p>	
<b>Unit 3 Microscopy</b>	
<p>Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Transmission Electron Microscope, Scanning Electron Microscope</p>	
<b>Unit 4 Phycology</b>	
<p>General characteristics of algae including occurrence, thallus organization, alga cell ultrastructure, pigments, flagella, eyespot, food reserves and vegetative, asexual and sexual reproduction</p> <p>General characters of the following classes:</p> <p>Chlorophyta, Xanthophyta, Cyanophyta</p> <p>Applications of algae in agriculture, industry, environment and food</p>	
<b>Unit 5 Mycology</b>	
<p>General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure</p>	



andsynthesis,asexualreproduction,sexualreproduction,heterokaryosis,heterothallism and parasexualmechanism

Economic importance offungi

### Unit 6 Protozoa

General characteristics with special reference to *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. McGrawHill 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 P1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

### INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

2 CREDITS

#### List of Practical

1. Microbiology Laboratory Management and Biosafety
2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuger, 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. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using permanent mounts
9. Study of *Spirogyra*, *Chlamydomonas* using permanent Mounts



10. Study of <i>Paramecium</i> , <i>Plasmodium</i> using permanent mounts
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### 3. Core T2: BACTERIOLOGY

<b>BACTERIOLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1 Cell organization</b>
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.
<b>Unit 2 Bacteriological techniques</b>
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.
<b>Unit 3 Growth and nutrition</b>
Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. <i>Physical methods of microbial control</i> : heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. <i>Chemical methods of microbial control</i> : disinfectants, types and mode of action.
<b>Unit 4 Reproduction in Bacteria</b>
Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.
<b>Unit 5 Bacterial Systematics</b>
Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; Characters used in bacterial systematic. Differences between eubacteria and archaeobacteria.
<b>Unit 6 Important archaeal and eubacterial groups</b>
<b>Archaeobacteria</b> : General characteristics, suitable example and economic importance. <b>Eubacteria</b> : General characteristics with suitable example.



**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:** An Introduction

**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 P2: BACTERIOLOGY****BACTERIOLOGY****2 CREDITS****List of Practical**

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, 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.



### 3. Core T3: BIOCHEMISTRY

<b>BIOCHEMISTRY</b>	
	<b>4 CREDITS</b>
<b>Unit 1 Bioenergetics</b>	
First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and 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, ATP.	
<b>Unit 2 Carbohydrates</b>	
General properties, 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, 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 and peptidoglycan.	
<b>Unit 3 Lipids</b>	
Fatty acids: definition, types, structures and functions, essential fatty acids. Lipid: definition, nomenclature and classification (triacylglycerols, phosphoglycerides, phosphatidylethanolamine, phosphatidylcholine, sphingosine, ceramide, sphingomyelins, cerebrosides and gangliosides) with structures and properties. Functions of lipid. Introduction of lipid micelles, monolayers, bilayers.	
<b>Unit 4 Proteins</b>	
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. 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. Human haemoglobin structure, Quaternary structures of Proteins.	
<b>Unit 5. Enzymes</b>	



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,  $K_m$  and allosteric mechanism, Lock and key hypothesis, and Induced Fit hypothesis. Definitions of terms – 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 and Nucleic Acids

Classification and characteristics with suitable examples, sources and importance.

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 P3: BIOCHEMISTRY

### BIOCHEMISTRY

2 CREDITS

### List of Practical

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 of enzyme kinetics – calculation of  $V_{max}$ ,  $K_m$ ,  $K_{cat}$  values.
6. Study the effect of temperature, pH and Heavy metals on enzyme activity (amylase).
7. Estimation of any one vitamin – Ascorbic acid.



### 3. Core T4:VIROLOGY

<b>VIROLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1: Nature and Properties of Viruses</b>
<p>Introduction: Discovery of viruses, nature and definition of viruses, general properties</p> <p>Concept of viroids, virusoids, satellite viruses and Prions</p> <p>Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses</p> <p>Isolation, purification and cultivation of viruses</p> <p>Viral taxonomy: Baltimore Classification</p>
<b>Unit 2: Bacteriophages</b>
<p>Diversity, classification, lytic and lysogenic cycle of T4/T2 phage</p> <p>concept of early and late proteins, regulation of transcription in lambda phage</p>
<b>Unit 3: Viral Transmission, Salient features of viral nucleic acids and Replication</b>
<p>Mode of viral transmission</p> <p>Structure, Nucleic acid, Replication and Symptoms of : Adenovirus, Retrovirus, Hepatitis B virus, Influenza virus</p> <p>Assembly, budding and maturation of HIV</p>
<b>Unit 4: Viruses and Cancer</b>
<p>Introduction to oncogenic viruses</p> <p>Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes</p>
<b>Unit 5: Prevention &amp; control of viral diseases</b>
<p>Antiviral compounds and their mode of action</p> <p>Interferon and their mode of action</p> <p>General principles of viral vaccination</p>
<b>Unit 6: Applications of Virology</b>
<p>Use of viral vectors in cloning and expression, Gene therapy and Phage display</p>
<b>Reference Books</b>
<ol style="list-style-type: none"> <li>1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.</li> <li>2. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc</li> <li>3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.</li> </ol>



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 P4:VIROLOGY

VIROLOGY	
	<b>2 CREDITS</b>
List of Practical	
<ol style="list-style-type: none"><li>1. Study of the structure of important animal viruses (Rhabdo and Retroviruses) using electron micrographs</li><li>2. Study of the structure of important plant viruses (TMV, Cucumber Mosaic Viruses) using electron micrographs</li><li>3. Study of the structure of important bacterial viruses (T4, <math>\lambda</math>) using electron micrograph.</li><li>4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique</li><li>5. Studying isolation and propagation of animal viruses by chick embryo technique</li><li>6. Report a visit to any educational Institute/ Industry</li></ol>	

**3. Core T5: MICROBIAL PHYSIOLOGY AND METABOLISM**

<b>MICROBIAL PHYSIOLOGY AND METABOLISM</b>	
	<b>4 CREDITS</b>
<b>Unit 1 Microbial Growth and Effect of Environment on Microbial Growth</b>	
<p>Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, 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 (Definition with example only) – Autotroph/Phototroph, heterotroph, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.</p>	
<b>Unit 2 Nutrient uptake and Transport</b>	
<p>Passive and facilitated diffusion.            Primary and secondary active transport, concept of uniport, symport and antiport.            Group translocation.            Iron uptake.</p>	
<b>Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration</b>	
<p>Concept of aerobic respiration.            Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway.            TCA cycle.            Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation.</p>	
<b>Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation</b>	
<p>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), concept of linear and branched fermentation pathways.</p>	
<b>Unit 5 Chemolithotrophic and Phototrophic Metabolism</b>	
<p>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.</p>	

**Unit 6 Nitrogen Metabolism - an overview**

Introduction to biological nitrogen fixation.

Ammonia assimilation.

Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

**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
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**3. Core P5: MICROBIAL PHYSIOLOGY AND METABOLISM****MICROBIAL PHYSIOLOGY AND METABOLISM****2 CREDITS****List of Practical**

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
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 alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.



### 3. Core T6:CELL BIOLOGY

<b>CELL BIOLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1 Structure and organization of Cell</b>
Cell Organization – Eukaryotic and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasmamembrane
<b>Unit 2 Nucleus</b>
Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus
<b>Unit 3 Protein Sorting and Transport</b>
Ribosomes Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, Proteinfolding, processing and quality control in ER, Smooth ER and lipid synthesis, Export of proteins and lipids from ER Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes
<b>Unit 4 Cell Signaling</b>
Modes of Cell to Cell Signaling Signaling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway
<b>Unit 5 Cell Cycle, Cell Death and Cell Renewal</b>
Regulation of Programmed cell death





Development of cancer, causes and types, p53 gene product  
Stem cells, Embryonic stem cell, induced pluripotent stem cells

### Reference Books

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. LipincottWilliams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

## Core P6: CELL BIOLOGY

### CELL BIOLOGY

**2 CREDITS**

#### List of Practical

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. Identification and study of cancer cells by photomicrographs
5. Study of different stages of Mitosis
6. Study of different stages of Meiosis



### 3. Core T7: MOLECULAR BIOLOGY

<b>MOLECULAR BIOLOGY</b>	
<b>4 CREDITS</b>	
<b>Unit 1 Structures of DNA and RNA / Genetic Material</b>	
DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of Genome: Prokaryotes ( <i>E.coli</i> ), Viruses (DNA virus-SV40, RNA virus-HIV), Eukaryotes ( <i>S.cerevisiae</i> ). RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.	
<b>Unit 2 Replication of DNA (Prokaryotes and Eukaryotes)</b>	
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 Various models of DNA replication including rolling circle, (theta) mode of replication, Mismatch and excision repair	
<b>Unit 3 Transcription in Prokaryotes and Eukaryotes</b>	
Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors.	
<b>Unit 4 Post-Transcriptional Processing</b>	
Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, its significance in brief.	
<b>Unit 5 Translation (Prokaryotes and Eukaryotes)</b>	
Translational machinery, Charging of tRNA, aminoacyltRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Inhibitors of protein synthesis in prokaryotes and eukaryote.	
<b>Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes</b>	
Principles of transcriptional regulation, regulation at initiation with examples from <i>lac</i> and <i>trp</i> operons, Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms.	
<b>Reference Books</b>	
1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6 <sup>th</sup> edition, Cold Spring Harbour Lab. Press, Pearson Publication 2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7 <sup>th</sup> edition,	



- Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8<sup>th</sup> edition. Lippincott Williams and Wilkins, Philadelphia
  4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6<sup>th</sup> edition, John Wiley & Sons. Inc.
  5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4<sup>th</sup> Edition, Cold Spring Harbour Laboratory press.
  6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3<sup>rd</sup> Ed., Jones and Bartlett Learning
  7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8<sup>th</sup> Ed. Wiley-India

## Core P7: MOLECULAR BIOLOGY

### MOLECULAR BIOLOGY

**2 CREDITS**

#### List of Practical

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer ( $A_{260}$  measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer ( $A_{260}$  measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).



### 3. Core T8: MICROBIAL GENETICS

<b>MICROBIAL GENETICS</b>
<b>4 CREDITS</b>
<b>Unit 1 Genome Organization and Mutations</b>
Genome organization of <i>E. coli</i> Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes
<b>Unit 2 Plasmids</b>
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids
<b>Unit 3 Mechanisms of Genetic Exchange</b>
Transformation - Discovery, mechanism, Identification of recombinants Conjugation - Discovery, mechanism, Hfr and F' strains Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers
<b>Unit 4 Phage Genetics</b>
Features of T4 genetics, Genetic basis of lytic <i>versus</i> lysogenic switch of phage lambda
<b>Unit 5 Transposable elements</b>
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition Uses of transposons and transposition
<b>Reference Books</b>
1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings 2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning 3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning 4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, Benjamin Cummings



## Core P8:MICROBIAL GENETICS

MICROBIAL GENETICS	
	<b>2 CREDITS</b>
<b>List of Practical</b>	
<ol style="list-style-type: none"><li>1. Preparation of Master and Replica Plates</li><li>2. Study the effect of chemical (<math>\text{HNO}_2</math>) and physical (UV) mutagens on bacterial cells</li><li>3. Study survival curve of bacteria after exposure to ultraviolet (UV) light</li><li>4. Isolation of Plasmid DNA from <i>E.coli</i></li><li>5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.</li><li>6. Demonstration of Bacterial Conjugation</li><li>7. Demonstration of bacterial transformation and transduction</li><li>8. Demonstration of AMES test</li></ol>	

**3. Core T9: ENVIRONMENTAL MICROBIOLOGY**

<b>ENVIRONMENTAL MICROBIOLOGY</b>	
	<b>4 CREDITS</b>
<b>Unit 1 Microorganisms and their Habitats</b>	
<p>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.</p> <p>Extreme Habitats: Extremophiles: Microbes thriving at high &amp; low temperatures, pH, high hydrostatic &amp; osmotic pressures, salinity, &amp; low nutrient levels.</p>	
<b>Unit 2 Microbial Interactions</b>	
<p>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.</p>	
<b>Unit 3 Biogeochemical Cycling</b>	
<p>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.</p>	
<b>Unit 4 Waste Management</b>	
<p>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.</p>	
<b>Unit 5 Microbial Bioremediation</b>	
<p>Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.</p>	
<b>Unit 6 Water Potability</b>	
<p>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.</p>	

**Reference Books**

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. 14<sup>th</sup> edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2<sup>nd</sup> edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1<sup>st</sup> 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. 1<sup>st</sup> 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. 4<sup>th</sup> edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9<sup>th</sup> edition. McGraw Hill Higher Education.

**Core P9: ENVIRONMENTAL MICROBIOLOGY****ENVIRONMENTAL MICROBIOLOGY****2 CREDITS****List of Practical**

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.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

**3. Core T10: FOOD AND DAIRY MICROBIOLOGY**

<b>FOOD AND DAIRY MICROBIOLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1 Foods as a substrate for microorganisms</b>
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.
<b>Unit 2 Microbial spoilage of various foods</b>
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods
<b>Unit 3 Principles and methods of food preservation</b>
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, ethylene oxide, antibiotics and bacteriocins
<b>Unit 4 Fermented foods</b>
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.
<b>Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventivemeasures)</b>
Food intoxications: <i>Staphylococcus aureus</i> , <i>Clostridium botulinum</i> and mycotoxins; Food infections: <i>Bacillus cereus</i> , <i>Vibrio parahaemolyticus</i> , <i>Escherichia coli</i> , Salmonellosis, <i>Yersinia enterocolitica</i> and <i>Campylobacter jejuni</i>
<b>Unit 6 Food sanitation and control</b>
HACCP, Indices of food sanitary quality and sanitizers
<b>Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.</b>
<b>Reference Books</b>
<ol style="list-style-type: none"> <li>1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.</li> <li>2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.</li> <li>3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.</li> <li>4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.</li> <li>5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.</li> <li>6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional,</li> </ol>





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.

## Core T10: FOOD AND DAIRY MICROBIOLOGY

FOOD AND DAIRY MICROBIOLOGY	
	<b>2 CREDITS</b>
List of Practical	
<ol style="list-style-type: none"><li>1. MBRT of milk samples and their standard plate count.</li><li>2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.</li><li>3. Isolation of any food borne bacteria from food products.</li><li>4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.</li><li>5. Isolation of spoilage microorganisms from bread.</li><li>6. Preparation of Yogurt/Dahi.</li></ol>	

**3. Core T11: INDUSTRIAL MICROBIOLOGY**

<b>INDUSTRIAL MICROBIOLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1 Introduction to industrial microbiology</b>
Brief history and developments in industrial microbiology
<b>Unit 2 Isolation of industrially important microbial strains and fermentation media</b>
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.
<b>Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameters</b>
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.
<b>Unit 4 Down-stream processing</b>
Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.
<b>Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)</b>
Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease) Wine, beer
<b>Unit 6 Enzyme immobilization</b>
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase)
<b>Reference Books</b>
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. 2nd



edition. Panima Publishing Co. New Delhi.  
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

## Core P11: INDUSTRIAL MICROBIOLOGY

<b>INDUSTRIAL MICROBIOLOGY</b>	
	<b>2 CREDITS</b>
<b>List of Practical</b>	
1. Study different parts of fermenter	
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:	
(a) Enzymes: Amylase and Protease	
(b) Amino acid: Glutamic acid	
(c) Organic acid: Citric acid	
(d) Alcohol: Ethanol	
3. A visit to any educational institute/industry.	



### 3. Core T12: IMMUNOLOGY

<b>IMMUNOLOGY</b>	
	<b>4 CREDITS</b>
<b>Unit 1 Introduction</b>	
Fundamental concept of Innate and Adaptive immunity Contributions of following scientists to the development of field of immunology - Edward Jenner, Louis Pasteur, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet and Rodney Porter	
<b>Unit 2 Immune Cells and Organs</b>	
Structure, Functions and Properties of: Immune Cells – B cell, T cell, NK cell, Macrophage, Dendritic cell, Stem cell Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen	
<b>Unit 3 Antigens</b>	
Characteristics of an antigen; T-dependent and T-independent antigens Concept of Epitopes, Adjuvants, Haptens, Carrier	
<b>Unit 4 Antibodies</b>	
Types, Structure, and Functions of antibodies Production and Clinical uses of Monoclonal antibodies	
<b>Unit 5 Major Histocompatibility Complex</b>	
Organization of MHC locus (Mice & Human) Structure and Functions of MHC I & II molecules	
<b>Unit 6 Complement System</b>	
Components of the Complement system Complement Activation pathways (Classical, Alternative and Lectin pathways) Biological consequences of complement Activation	
<b>Unit 7 Generation of Immune Response</b>	
Generation of Humoral and Cell Mediated Immune Response Antibody dependent cellular cytotoxicity (ADCC)	
<b>Unit 8 Types of Immunization</b>	
Characteristics and functions of Active and Passive Immunization	
<b>Unit 9 Immunological Techniques</b>	
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA,	



ELISPOT, Western blotting, Immunofluoresence, Immunoelectron microscopy

### Reference Books

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.

## Core P12: IMMUNOLOGY

### IMMUNOLOGY

2 CREDITS

#### List of Practical

1. Identification of human blood groups
2. Perform Total Leukocyte Count of the given blood sample
3. Separate serum from the blood sample (demonstration)
4. Demonstration of immunoelectrophoresis
5. Perform immunodiffusion by Ouchterlony method
6. Perform DOT ELISA



### 3. Core T13: MEDICAL MICROBIOLOGY

<b>MEDICAL MICROBIOLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1 Normal microflora of the human body and host pathogen interaction</b>
Normal microflora of skin, respiratory tract, gastrointestinal tract, urogenital tract Host pathogen interaction: Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers, reservoir, Opportunistic infections, Nosocomial infections, Epidemic, Endemic, Pandemic
<b>Unit 2 Bacterial diseases</b>
Symptoms, mode of transmission, prophylaxis and control of following diseases: Respiratory Diseases: <i>Streptococcus pyogenes</i> , <i>Mycobacterium tuberculosis</i> Gastrointestinal Diseases: <i>Salmonella typhi</i> , <i>Vibrio cholerae</i> Others: <i>Bacillus anthracis</i> , <i>Treponema pallidum</i>
<b>Unit 3 Viral diseases</b>
Symptoms, mode of transmission, prophylaxis and control of following diseases: AIDS, Ebola, Dengue, Chikungunya, Japanese Encephalitis
<b>Unit 4 Protozoan diseases</b>
Symptoms, mode of transmission, prophylaxis and control of following diseases: Malaria, Kala-azar
<b>Unit 5 Fungal diseases</b>
Transmission, symptoms and prevention of following diseases: Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis
<b>Unit 6 Antimicrobial agents: General characteristics and mode of action</b>
Modes of action of Antibacterial, Antifungal and Antiviral agents with example
<b>Reference Books</b>
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. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc

### Core P13: MEDICAL MICROBIOLOGY

MEDICAL MICROBIOLOGY	
	2 CREDITS
List of Practical	
<ol style="list-style-type: none"><li>1. Identify bacteria (<i>Bacillus</i>, <i>Staphylococcus</i>, <i>E. coli</i>, <i>Pseudomonas</i>,) on the basis of cultural, morphological and biochemical characteristics</li><li>2. Study of composition and use of important differential media for identification of bacteria: EMBAgar, McConkey agar, Mannitol salt agar, TCBS</li><li>3. Study of bacterial flora of skin by swab method</li><li>4. Perform antibacterial sensitivity by Agar cup method</li><li>5. Determination of minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/Streptomycin)</li><li>6. Study of various stages of Malarial parasite in RBC using permanent mount</li></ol>	



### 3. Core T14: RECOMBINANT DNA TECHNOLOGY

<b>RECOMBINANT DNA TECHNOLOGY</b>
<b>4 CREDITS</b>
<b>Unit 1 Introduction to Genetic Engineering</b>
Milestones in genetic engineering and biotechnology
<b>Unit 2 Molecular Cloning- Tools and Strategies</b>
Mode of action and applications of Type I, II and III restriction endonuclease in genetic engineering;
Definition and function of restriction site, linkers, adaptors, Topoisomerase, DNA ligase, Genomic library
DNA Modifying enzymes: Terminal deoxynucleotidyltransferase, kinases, phosphatase
Definition and Properties of following Cloning Vectors:
pBR322, pUC8, Bacteriophage lambda, M13, Cosmids, BACs and YACs vectors
Mammalian SV40-based expression vectors
<b>Unit 3 Methods in Molecular Cloning</b>
Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, <i>Agrobacterium</i> - mediated delivery
Agarose gel electrophoresis, Southern and Northern blotting, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting
<b>Unit 4 DNA Amplification and DNA sequencing</b>
Basic concept of PCR, RT-PCR, Real-Time PCR
Sanger's method of DNA Sequencing: traditional and automated sequencing
Primer walking and shotgun sequencing
<b>Unit 5 Construction and Screening of Genomic and cDNA libraries</b>
Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping



**Unit 6 Applications of Recombinant DNA Technology**

Products of recombinant DNA technology:

Insulin, hGH, Antisense molecules

Bt transgenic - cotton, brinjal

Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis

**Reference Books**

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

**3. Core P14: RECOMBINANT DNA TECHNOLOGY****RECOMBINANT DNA TECHNOLOGY****2 CREDITS****List of Practical**

1. Perform bacterial Transformation by standard method
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3. Ligation of DNA fragments
4. Interpretation of sequencing gel electropherograms
5. Designing of primers for DNA amplification
6. Demonstration of amplification of DNA by PCR
7. Perform Southern blotting



**B.Sc. (HONOURS) MICROBIOLOGY (CBCS  
STRUCTURE)  
DISCIPLINE SPECIFIC ELECTIVES**



### 3. DSE-T1: BIOINFORMATICS

<b>BIOINFORMATICS</b>
<b>4 CREDITS</b>
<b>Unit 1 Introduction to Computer Fundamentals</b>
RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer
<b>Unit 2 Introduction to Bioinformatics and Biological Databases</b>
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
<b>Unit 3 Sequence Alignments, Phylogeny and Phylogenetic trees</b>
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
<b>Unit 4 Genome organization and analysis</b>
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes Genome, transcriptome, proteome, 2-D gel electrophoresis, MaldiToff spectroscopy Major features of completed genomes: <i>E.coli</i> , <i>S.cerevisiae</i> , <i>Arabidopsis</i> , Human
<b>Unit 5 Protein Structure Predictions</b>
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 Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design
<b>Reference Books</b>
1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House 2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4 <sup>th</sup> ed., BPB Publications 3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3 <sup>rd</sup> International Student Edition 4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2 <sup>nd</sup> ed. Prentice Hall India Publication 5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell



## DSE-P1: BIOINFORMATICS

<b>BIOINFORMATICS</b>	
	<b>2 CREDITS</b>
<b>List of Practical</b>	
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	

**DSE-2: DISSERTATION WORK WITH SEMINAR**

<b>DISSERTATION WORK WITH SEMINAR</b>	
	<b>6 CREDITS</b>
<b>Unit 1</b>	
<p>This paper would focus on the project work / Dissertation to be carried out by the students under the supervision of the teacher(s) in the college/ Research Institute.</p> <p>The topic of the project would be selected by each student in consultation with the supervisor.</p> <p>The Dissertation of the student must include: Objectives, Review of Literature, Methodology, Result and Discussion.</p> <p>The grading would be based on continuous evaluation that would include punctuality, hard work, record keeping, intellectual inputs, data presentation, interpretation etc.</p> <p>Finally, the student has to present a seminar at the time of submission of the Dissertation.</p>	

**DSE-T3: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT**

<b>MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT</b>	
	<b>4 CREDITS</b>
<b>Unit 1 Soil Microbiology</b>	
Soil as Microbial Habitat Diversity and distribution of microorganisms in soil	
<b>Unit 2 Mineralization of Organic &amp; Inorganic Matter in Soil</b>	
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium	
<b>Unit 3 Microbial Activity in Soil and Green House Gases</b>	
Carbon dioxide, methane – production and control	
<b>Unit 4 Microbial Control of Soil Borne Plant Pathogens</b>	
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	
<b>Unit 5 Biofertilization, Phytostimulation, Bioinsecticides</b>	
General concept of Biofertilizers – Phosphate solubilizing Microorganism Nitrogen fixing Microorganism (Symbiotic and Non Symbiotic)	
<b>Unit 6 Secondary Agriculture Biotechnology</b>	
Biomass, biogas, biofuels – Principle, advantages and processing parameters	
<b>Unit 7 GM crops</b>	
Advantages, social and environmental aspects of Bt crops, golden rice, transgenic animals	
<b>Reference Books</b>	
<ol style="list-style-type: none"> <li>1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego, 2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford &amp; IBH, New Delhi.</li> <li>3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,</li> <li>4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals &amp; Applications. 4th edition. Benjamin/Cummings Science Publishing, USA</li> <li>5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition,</li> </ol>	



Academic Press

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

### DSE-P3: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

<b>MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT</b>	
	<b>2 CREDITS</b>
<b>List of Practical</b>	
<ol style="list-style-type: none"><li>1. Study soil profile</li><li>2. Study microflora of different types of soils</li><li>3. Isolation and characteristics of <i>Rhizobium</i> from leguminous plant</li><li>4. Demonstration of biogas plant</li><li>6. Isolation of cellulose degrading microorganisms</li></ol>	

**DSE-T4: INSTRUMENTATION AND BIOTECHNIQUES**

<b>INSTRUMENTATION AND BIOTECHNIQUES</b>
<b>4 CREDITS</b>
<b>Unit 1 Microscopy</b>
Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.
<b>Unit 2 Chromatography</b>
Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ionexchange chromatography and affinity chromatography, GLC, HPLC.
<b>Unit 3 Electrophoresis</b>
Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, and Agarose gel electrophoresis.
<b>Unit 4 Spectrophotometry</b>
Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.
<b>Unit 5 Centrifugation</b>
Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, principle and application of differential centrifugation, density gradient centrifugation and ultracentrifugation.
<b>Reference Books</b>
<ol style="list-style-type: none"> <li>1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Ed., Cambridge University Press.</li> <li>2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5<sup>th</sup> Ed., W.H. Freeman and Company.</li> <li>3. Willey MJ, Sherwood LM &amp; Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9<sup>th</sup> Ed., McGraw Hill.</li> <li>4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6<sup>th</sup> edition. John Wiley &amp; Sons. Inc.</li> <li>5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8<sup>th</sup> edition. Lipincott Williams and Wilkins, Philadelphia.</li> </ol>





6. 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.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

## DSC-P4: INSTRUMENTATION AND BIOTECHNIQUES

### **INSTRUMENTATION AND BIOTECHNIQUES**

**2 CREDITS**

#### **List of Practical**

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of  $\lambda_{max}$  for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Industrial Tour



**B.Sc. (HONOURS) MICROBIOLOGY (CBCS  
STRUCTURE)  
SKILL ENHANCEMENT COURSES**

**SE-1: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER**

<b>MICROBIOLOGICAL ANALYSIS OF AIR AND WATER</b>
<b>4 CREDITS</b>
<b>Unit 1 Aeromicrobiology</b>
Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi, each from every category) and their impact on human health, and environment, significance in food and pharma industries and operation theatres, allergens.
<b>Unit 2 Air Sample Collection and Analysis</b>
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics
<b>Unit 3 Control Measures</b>
Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration
<b>Unit 4 Water Microbiology</b>
Water borne pathogens, water borne diseases
<b>Unit 5 Microbiological Analysis of Water</b>
Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests
<b>Unit 6 Control Measures</b>
Precipitation, chemical disinfection, filtration, high temperature, UV light
<b>Reference Books</b>
<ol style="list-style-type: none"> <li>1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water A Laboratory Manual, CRC Press</li> <li>2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals &amp; Applications. 4<sup>th</sup> edition. Benjamin/Cummings Science Publishing, USA</li> <li>3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2<sup>nd</sup> edition, Academic Press</li> <li>4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3<sup>rd</sup> edition, ASM press</li> </ol>

**SE-2: MICROBIAL DIAGNOSIS IN HEALTH CLINICS**

<b>MICROBIAL DIAGNOSIS IN HEALTH CLINICS</b>	
	<b>2 CREDITS</b>
<b>Unit 1 Importance of Diagnosis of Diseases</b>	
Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis	
<b>Unit 2 Collection of Clinical Samples</b>	
Collection of clinical samples (Sputum, Skin, Blood, Urine and Stool) with proper precautions Method of transport of clinical samples to the laboratory and storage	
<b>Unit 3 Direct Microscopic Examination and Culture</b>	
Examination of sample by staining - Gram staining, Ziehl-Neelson staining, Giemsa staining Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar	
<b>Unit 4: Serological and Molecular Methods</b>	
Serological Methods - Agglutination, ELISA, Immunofluorescence, Nucleic acid based methods -PCR, Nucleic acid probes	
<b>Unit 5: Kits for Rapid Detection of Pathogens</b>	
Typhoid, Dengue and HIV	
<b>Unit 6: Testing for Antibiotic Sensitivity in Bacteria</b>	
Determination of resistance/sensitivity of bacteria against antibiotic (Penicillin/Streptomycin) using disc diffusion method Determination of minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/Streptomycin)	
<b>Reference Books</b>	
<ol style="list-style-type: none"> <li>1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.</li> <li>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</li> <li>3. Collee JG, Duguid JP, Fraser AG, Marmion BP (1989) Practical Medical Microbiology, 13<sup>th</sup> edition, Churchill Livingstone</li> <li>4. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2<sup>nd</sup> edition, Elsevier India Pvt Ltd</li> </ol>	

