

**WEST BENGAL STATE UNIVERSITY**

**CBCS DRAFT SYLLABUS**

**FOR**

**THREE-YEAR MICROBIOLOGY HONOURS**

**DEGREE COURSE OF STUDIES**

## **Structure of B. Sc. Honours Microbiology under CBCS**

### **Core Course**

MCBACOR01T/P: Introduction to Microbiology and Microbial Diversity  
MCBACOR02T/P: Bacteriology  
MCBACOR03T/P: Biochemistry  
MCBACOR04T/P: Environmental Microbiology  
MCBACOR05T/P: Microbial Physiology and Metabolism  
MCBACOR06T/P: Cell Biology  
MCBACOR07T/P: Molecular Biology  
MCBACOR08T/P: Microbial Genetics  
MCBACOR09T/P: Virology  
MCBACOR10T/P: Food and Dairy Microbiology  
MCBACOR11T/P: Industrial Microbiology  
MCBACOR12T/P: Immunology  
MCBACOR13T/P: Medical Microbiology  
MCBACOR14T/P: Recombinant DNA Technology

### **Discipline Specific Elective (Any Four)(out of 3 any 2 to be taken in each semester)**

MCBADSE01T/P: Advances in Microbiology – Semester V  
MCBADSE02T/P: Biomathematics and Biostatistics - Semester V  
MCBADSE03T/P: Inheritance Biology - Semester V  
MCBADSE04T/P: Microbes in Sustainable Agriculture and Development- Semester VI  
MCBADSE05T/P: Biosafety and Intellectual Property Rights – Semester VI  
MCBADSE06T/P: Instrumentation and Biotechniques – Semester VI

### **Skill Enhancement Elective Courses**

MCBSSEC01M: Food fermentation techniques  
MCBSSEC02M: Microbiological Analysis of Air and Water

### **[Generic Electives: ONLY FOR THE STUDENTS PURSUING HONOURS COURSE OTHER THAN MICROBIOLOGY]**

MCBHGEC01T/P: Bacteriology and Virology  
MCBHGEC02T/P: Industrial and Food Microbiology  
MCBHGEC03T/P: Microbial genetics and molecular biology  
MCBHGEC04T/P: Medical Microbiology and Immunology

### Microbiology (Hons.) Semester I

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MCBACOR01T	Introduction to Microbiology and Microbial Diversity (Theory)	4	10	40
MCBACOR01P	Introduction to Microbiology and Microbial Diversity (Practical)	2	15	10
MCBACOR02T	Bacteriology (Theory)	4	10	40
MCBACOR02P	Bacteriology (Practical)	2	15	10
<b>Total in semester I</b>		<b>12</b>	<b>150</b>	

Besides this, a student has to complete **one Generic Elective course (6 credits/ 75 marks)** from the Departments other than Microbiology and **one Ability enhancement Compulsory Course (2 credit/25 marks)**

- **Therefore, a student covers a total of 20 credits (12+6+2) in Semester I**

### Microbiology (Hons.) Semester II

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MCBACOR03T	Biochemistry (Theory)	4	10	40
MCBACOR03P	Biochemistry (Practical)	2	15	10
MCBACOR04T	Environmental Microbiology (Theory)	4	10	40
MCBACOR04P	Environmental Microbiology (Practical)	2	15	10
<b>Total in semester II</b>		<b>12</b>	<b>150</b>	

Besides this, a student has to complete **one Generic Elective course (6 credits/75 marks)** from the Departments other than Microbiology and **one Ability enhancement Compulsory Course (2 credit/25 marks)**

- Therefore, a student covers a total of 20 credits (12+6+2) in Semester II

### Microbiology (Hons.) Semester III

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MCBACOR05T	Microbial Physiology and Metabolism (Theory)	4	10	40
MCBACOR05P	Microbial Physiology and Metabolism (Practical)	2	15	10
MCBACOR06T	Cell Biology (Theory)	4	10	40
MCBACOR06P	Cell Biology (Practical)	2	15	10
MCBACOR07T	Molecular Biology (Theory)	4	10	40
MCBACOR07P	Molecular Biology (Practical)	2	15	10
MCBSSEC01M	Food fermentation techniques	2	05	20
<b>Total in semester III</b>		<b>20</b>	<b>250</b>	

Besides this, a student has to complete **one Generic Elective course (6 credits/75 marks)** from the Departments other than Microbiology.

- Therefore, a student covers a total of 26 credits (20+6) in Semester III

### Microbiology (Hons.) Semester IV

Course Code	Course Title	Credit	Marks	
			Internal Assessment	End Sem Examination
MCBACOR08T	Microbial Genetics (Theory)	4	10	40
MCBACOR08P	Microbial Genetics (Practical)	2	15	10
MCBACOR09T	Virology (Theory)	4	10	40
MCBACOR09P	Virology (Practical)	2	15	10
MCBACOR10T	Food and Dairy Microbiology (Theory)	4	10	40
MCBACOR10P	Food and Dairy Microbiology (Practical)	2	15	10

MCBSSEC02M	Microbiological Analysis of Air and Water	2	05	20
<b>Total in semester IV</b>		<b>20</b>	<b>250</b>	
<p>Besides this, a student has to complete <b>one Generic Elective course (6 credits/75 marks)</b> from the Departments other than Microbiology.</p> <p><b>Therefore, a student covers a total of 26 credits (20+6) in Semester IV</b></p>				

**Microbiology (Hons.) Semester V**

Course Code	Course Title	Credit	Marks	
			Internal Assessment	Examination
MCBACOR11T	Industrial Microbiology (Theory)	4	10	40
MCBACOR11P	Industrial Microbiology (Practical)	2	15	10
MCBACOR12T	Immunology (Theory)	4	10	40
MCBACOR12P	Immunology (Practical)	2	15	10
MCBADSE01T/ MCBADSE02T/ MCBADSE03T	Advances in Microbiology / Biomathematics and Biostatistics / Inheritance Biology <b>(ANY TWO)</b>	2x4	10x2	40x2
MCBADSE01P/ MCBADSE02P/ MCBADSE03P	Advances in Microbiology / Biomathematics and Biostatistics / Inheritance Biology (Practical) <b>(ANY TWO)</b>	2x2	15x2	10x2
<b>Total in semester V</b>		<b>24</b>	<b>300</b>	

**Microbiology (Hons.) Semester VI**

Course Code	Course Title	Credit	Marks	
			Internal Assessment	Examination
MCBACOR13T	Medical Microbiology (Theory)	4	10	40
MCBACOR13P	Medical Microbiology (Practical)	2	15	10
MCBACOR14T	Recombinant DNA Technology (Theory)	4	10	40
MCBACOR14P	Recombinant DNA Technology (Practical)	2	15	10
MCBADSE04T/ MCBADSE05T/ MCBADSE06T	Microbes in sustainable Agriculture and Development/ Biosafety and Intellectual Property Rights/ Instrumentation and Biotechniques (Theory)  (ANY TWO)	2x4	10x2	40x2
MCBADSE04P/ MCBADSE05P/ MCBADSE06P	Microbes in sustainable Agriculture and Development/ Biosafety and Intellectual Property Rights/ Instrumentation and Biotechniques (Practical)  (ANY TWO)	2x2	15x2	10x2
<b>Total in semester VI</b>		<b>24</b>	<b>300</b>	

**TOTAL CREDIT = 140**

**TOTAL MARKS = 1750**

## B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

### MCBACOR01T: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (THEORY) SEMESTER –I

TOTAL HOURS: 60

CREDITS: 4

#### **Unit 1 History of Development and scope of Microbiology** **No. of Hours: 8**

Development of Microbiology as a discipline, spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman  
Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

#### **Unit 2 Microscopy: Basic principles & application** **No. of Hours: 10**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

#### **Unit 3 Diversity of Microbial World** **No. of Hours: 42:**

##### **A. Systems of classification**

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

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

**B. General characteristics** of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

##### **• Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food

##### **• Fungi**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• **Protozoa**

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

**MCBACOR01P: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (PRACTICALS) SEMESTER –I**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Microbiology Good Laboratory Practices and safety measures.
2. To study the principle and applications of important instruments (Laminar Air Flow, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of Czapekdox Agar slant/plate for fungal cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Inoculation of fungi (*Penicillium*, *Aspergillus*) in Czapekdox medium
6. Staining of fungi (*Rhizopus*, *Penicillium*, *Aspergillus*) using Lactophenol-Cotton blue

**SUGGESTED READING**

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

**MCBACOR02T: BACTERIOLOGY (THEORY) SEMESTER –I**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Cell organization**

**No. of Hours: 18**

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, and plasmids(definition and types), Endospore: Structure, formation, stages of sporulation.

**Unit 2 Bacteriological techniques**

**No. of Hours: 6**



Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, non-culturable bacteria. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media

### **Unit 3 Staining methods**

**No. of Hours: 6**

Stain and dye, acidic and basic dyes, mordant, Simple staining, Gram staining, Negative staining, Acid fast staining, Basic mechanism of Gram staining, endospore and capsule staining, Basic mechanism of Lactophenol-cotton blue staining

### **Unit 4 Microbial Growth and Effect of Environment on Microbial Growth**

**No. of Hours: 18**

Definitions of growth, Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate 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, pH, solute and water activity, Oxygen, high pressure. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

*Physical methods of microbial control:* heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation

*Chemical methods of microbial control:* Acid, alkali, alcohol, detergent, phenol & phenolics, heavy metals: types and mode of action, disinfectants and antiseptics; basic concept of antibiotics.

### **Unit 5 Important archaeal and eubacterial groups**

**No. of Hours: 12**

**Archaeobacteria:** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

#### **Eubacteria:**

##### ***Gram Negative:***

Non proteobacteria: General characteristics with suitable examples

Alpha proteobacteria: General characteristics with suitable examples

Beta proteobacteria: General characteristics with suitable examples

Gamma proteobacteria: General characteristics with suitable examples

Delta proteobacteria: General characteristics with suitable examples

Epsilon proteobacteria: General characteristics with suitable examples

Zeta proteobacteria: General characteristics with suitable examples

##### ***Gram Positive:***

Low G+ C (Firmicutes): General characteristics with suitable examples

High G+C (Actinobacteria): General characteristics with suitable examples

**Cyanobacteria:** Introductory idea with suitable example

## **MCBACOR02P: BACTERIOLOGY (PRACTICAL) SEMESTER –I**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Preparation of different media: Nutrient Agar & broth, Luria broth
2. Simple staining
3. Negative staining
4. Gram staining
5. Endospore staining.

6. Isolation of pure cultures of bacteria by streaking method.
7. Study and plot the growth curve of *E. coli* by turbidometric method.
8. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
9. Estimation of CFU count by spread plate method/pour plate method.

### **SUGGESTED READINGS**

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

## **MCBACOR03T: BIOCHEMISTRY (THEORY)**

### **SEMESTER –II**

**TOTAL HOURS: 60**

**CREDITS: 4**

#### **Unit 1 Bioenergetics**

**No. of Hours: 8**

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, Standard Free Energy Change of coupled reactions, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP, . Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant

#### **Unit 2 Carbohydrates**

**No. of Hours: 12**

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

#### **Unit 3 Lipids**

**No. of Hours: 12**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and

phosphatidylcholine,

Sphingolipids.

#### **Unit 4 Proteins**

**No. of Hours: 12**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Concept of pH and buffers and related numerical problems, 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. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

#### **Unit 5. Enzymes**

**No. of Hours: 16**

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

### **MCBACOR03P: BIOCHEMISTRY (PRACTICALS) SEMESTER –II**

**TOTAL HOURS: 60**

**CREDITS: 2**

- 1.Preparation of buffers and numerical problems to explain the concepts
2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
3. Qualitative/Quantitative tests for proteins: Biuret & Lowry's method
4. Formol titration of glycine
5. Study of enzyme kinetics – calculation of  $V_{max}$  , Km, Kcat values
6. Study effect of temperature, pH and Heavy metals on enzyme activity

#### **SUGGESTED READING**

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,

**MCBACOR04T: ENVIRONMENTAL MICROBIOLOGY (THEORY)**  
**SEMESTER –II**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Microorganisms and their Habitats**

**No. of Hours: 14**

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

**Unit 2 Microbial Interactions**

**No. of Hours: 12**

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

**Unit 3 Biogeochemical Cycling**

**No. of Hours: 12**

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

**Unit 4 Waste Management**

**No. of Hours: 12**

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

**Unit 5 Microbial Bioremediation**

**No. of Hours: 5**

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

**Unit 6 Water Potability**

**No. of Hours: 5**

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

**MCBACOR04P: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)  
SEMESTER –II**

**TOTAL HOURS: 60**

**CREDITS: 2.**

1. Isolation of microbes (bacteria & fungi) from soil.
2. Isolation of microbes from rhizosphere and phyllosphere.
3. Assessment of microbiological quality of water.
4. Determination of BOD of waste water sample.
5. Study of amylase production by soil bacteria (qualitative).

**SUGGESTED READINGS**

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.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**MCBACOR05T: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)  
SEMESTER –III**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Nutrient uptake and Transport**

**No. of Hours: 10**

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

**Unit 2 Chemoheterotrophic Metabolism - Aerobic Respiration      No. of Hours: 16**

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, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

**Unit 3 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation  
No. of Hours:12**

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 mixed acid fermentation.

**Unit 4 Chemolithotrophic and Phototrophic Metabolism      No. of Hours: 16**

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

**Unit 5 Nitrogen Metabolism - an overview      No. of Hours: 6**

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

**MCBACOR05P: MICROBIAL PHYSIOLOGY AND METABOLISM  
(PRACTICAL)  
SEMESTER –III**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Effect of temperature on growth of *E. coli*
2. Effect of pH on growth of *E. coli*
3. Effect of carbon and nitrogen sources on growth of *E.coli*
4. Effect of salt on growth of *E. coli*
5. Demonstration of alcoholic fermentation

**SUGGESTED READINGS**

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 JJ, 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.

**MCBACOR06T: CELL BIOLOGY (THEORY)**  
**SEMESTER –III**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Structure and organization of Eukaryotic Cell** **No. of Hours: 14**

Cell Organization – Eukaryotic (Plant and animal cells)  
Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell

Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes

Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

**Unit 2 Nucleus** **No. of Hours: 6**

Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization  
Nucleolus

**Unit 3 Basics of Protein Sorting and Transport** **No. of Hours: 12**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, smooth ER, export of proteins to Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

**Unit 4 Introduction to Cell Signalling** **No. of Hours: 13**

Signalling molecules and their receptors Function of cell surface receptors  
Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP

**Unit 5 Cell Cycle** **No. of Hours: 15**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types Programmed cell death.

**MCBACOR06P: CELL BIOLOGY (PRACTICAL)**  
**SEMESTER –III**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Study a representative plant (*Allium cepa* or any other suitable plant material) and animal (squamous epithelial cells) cell by microscopy.
2. Cytochemical staining of DNA – Feulgen
3. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
4. Study of different stages of Mitosis.
5. Study of different stages of Meiosis.

**SUGGESTED****READING**

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. Lipincott Williams and Wilkins, Philadelphia.
4. 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.

**MCBACOR07T: MOLECULAR BIOLOGY (THEORY)****SEMESTER –III****TOTAL HOURS: 60****CREDITS: 4****Unit 1 Structures of DNA and RNA / Genetic Material** **No. of Hours: 12**

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 DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

**Unit 2 Replication of DNA (Prokaryotes and Eukaryotes)** **No. of Hours: 10**

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, D- loop (mitochondrial),  $\Theta$  (theta) mode of replication and other accessory protein.

**Unit 3 Transcription** **No. of Hours: 8**

Transcription in prokaryotes: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit  
Transcription in Eukaryotes: RNA polymerases, general Transcription factors (outline only)

**Unit 4 Basic concept of Post-Transcriptional Processing** **No. of Hours: 8**

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, miRNA and its significance

**Unit 5 Translation** **No. of Hours: 10**

Prokaryotic Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides. Fidelity of translation, Inhibitors of protein synthesis in prokaryotes. Difference between eukaryotic and prokaryotic translation

**Unit 6 Regulation of gene Expression** **No. of Hours:12**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus*, Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.



## MCBACOR07P: MOLECULAR BIOLOGY (PRACTICAL)

### SEMESTER –III

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Estimation of DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
2. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)
3. Isolation of genomic DNA from *E. coli*
4. Determination of Purity of isolated DNA
5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE): Demonstration only.

### SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th 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, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

## MCBACOR08T: MICROBIAL GENETICS (THEORY)

### SEMESTER –IV

**TOTAL HOURS: 60**

**CREDITS: 4**

#### **Unit 1 Genome Organization, Mutation & DNA repair**

**No. of Hours: 22**

Genome organization: *E. coli*, Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes, Repair: phoreactivation, NER, SOS, mismatch.

#### **Unit 2 Plasmids**

**No. of Hours: 10**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2  $\mu$  plasmid, Plasmid replication and partitioning, Host range,

plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

**Unit 3 Mechanisms of Genetic Exchange**

**No. of Hours: 20**

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

**Unit 4 Transposable elements**

**No. of Hours: 8**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition

**MCBACOR08P: MICROBIAL GENETICS**

**(PRACTICAL)**

**SEMESTER –IV**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Preparation of Master and Replica Plates
2. Effect of ultraviolet (UV) light exposure on bacterial survival
3. Isolation of Plasmid DNA from *E.coli*
4. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
5. Bacterial Conjugation

**SUGGESTED READING**

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, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4<sup>th</sup> Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

**MCBACOR09T: VIROLOGY (THEORY)**

**SEMESTER –IV**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Nature and Properties of Viruses**

**No. of Hours: 12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses  
Isolation, purification and cultivation of viruses  
Viral taxonomy: Classification and nomenclature of different groups of viruses:  
Baltimore classification, ICTV classification

**Unit 2 Bacteriophages & phage genetics**

**No. of Hours: 10**

Diversity, classification, one step multiplication curve, lytic and lysogenic phages ( $\lambda$  phage) concept of early and late proteins, regulation of transcription in  $\lambda$  phage

**Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication**

**No. of Hours: 22**

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal  
Salient features of viral Nucleic acid : Unusual bases (TMV, T4 phage), overlapping genes ( $\phi$ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV), Viral multiplication and replication strategies, Viral Assembly, maturation and release (Adeno virus and influenza virus as example)

**Unit 4 Viruses and Cancer**

**No. of Hours: 6**

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

**Unit 5 Prevention & control of viral diseases**

**No. of Hours: 10**

Antiviral compounds and their mode of action Interferon and their mode of action  
General principles of viral vaccination, Mechanism of action of Amantadine,  
Acyclovir, Azidothymidine

**MCBACOR09P: VIROLOGY (PRACTICAL)**

**SEMESTER –IV**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Plaque assay of bacteriophages from standard teaching kit
2. Isolation and enumeration of bacteriophages (PFU) from water/sewage/cow dung sample using double agar layer technique (demonstration only)

**SUGGESTED READING**

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. 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.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

**MCBACOR10T: FOOD & DAIRY MICROBIOLOGY (THEORY)**  
**SEMESTER –IV**

**TOTAL HOURS: 60**

**CREDITS: 4**

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

**No. of Hours: 8**

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

**Unit 2 Microbial spoilage of various foods**

**No. of Hours: 10**

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

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

**No. of Hours: 12**

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

**Unit 4 Fermented foods**

**No. of Hours: 12**

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

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

**No. of Hours: 12**

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

**Unit 6 Food sanitation and control**

**No. of Hours: 6**

HACCP, Indices of food sanitary quality and sanitizers

**MCBACOR10P: FOOD & DAIRY MICROBIOLOGY (PRACTICAL)**  
**SEMESTER –IV**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.

**SUGGESTED READINGS**

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.

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

## **MCBACOR11T: INDUSTRIAL MICROBIOLOGY (THEORY)**

### **SEMESTER –V**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Introduction to industrial microbiology**

**No. of Hours: 2**

Brief history and developments in industrial microbiology

**Unit 2 Isolation of industrially important microbial strains and fermentation media**

**No. of Hours: 12**

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

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

**No. of Hours: 14**

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

**Unit 4 Down-stream processing**

**No. of Hours: 6**

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

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

**No. of Hours: 20**

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

**Unit 6 Enzyme immobilization**

**No. of Hours: 6**

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

**MCBACOR11P: INDUSTRIAL MICROBIOLOGY (PRACTICAL)**  
**SEMESTER –V**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Microbial fermentations for the production and estimation (qualitative and quantitative) of (a) Enzymes: Amylase  
(b) Organic acid: Citric acid/Lactic acid  
(c) Alcohol: Ethanol
2. A visit to any industry to see industrial fermentation and other downstream processing operations.

**SUGGESTED READINGS**

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 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.

**MCBACOR12T: IMMUNOLOGY (THEORY)**  
**SEMESTER –V**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Introduction**

**No. of Hours: 4**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

**Unit 2 Immune Cells and Organs**

**No. of Hours: 7**

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

**Unit 3 Antigens**

**No. of Hours: 4**

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

**Unit 4 Antibodies**

**No. of Hours: 6**

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

**Unit 5 Major Histocompatibility Complex****No. of Hours: 5**

Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

**Unit 6 Complement System****No. of Hours: 4**

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

**Unit 7 Generation of Immune Response****No. of Hours: 10**

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

**Unit 8 Immunological Disorders and Tumor Immunity****No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), tumor antigens

**Unit 9 Immunological Techniques****No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry

**MCBACOR12P: IMMUNOLOGY  
(PRACTICAL)  
SEMESTER –V**

**TOTAL HOURS: 60****CREDITS: 2**

1. Identification of human blood groups.
2. Single Radial Immuno Diffusion
3. Immunodiffusion by Ouchterlony method.
4. DOT ELISA (Demonstration)
5. Immunoelectrophoresis.

**SUGGESTED READINGS**

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

## MCBACOR13T: MEDICAL MICROBIOLOGY (THEORY)

### SEMESTER –VI

**TOTAL HOURS: 60**

**CREDITS: 4**

#### **Unit 1 Normal microflora of the human body and host pathogen interaction**

**No. of Hours: 8**

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

#### **Unit 2 Sample collection, transport and diagnosis**

**No. of Hours: 5**

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

#### **Unit 3 Bacterial diseases**

**No. of Hours: 15**

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

Respiratory Diseases: *Haemophilus influenzae*, *Mycobacterium tuberculosis*

Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*

#### **Unit 4 Viral diseases**

**No. of Hours: 14**

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

Polio, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

#### **Unit 5 Protozoan diseases**

**No. of Hours: 5**

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

Malaria, Kala-azar

#### **Unit 6 Fungal diseases**

**No. of Hours: 5**

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention

Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

#### **Unit 7 Antimicrobial agents: General characteristics & mode of action**

**No. of Hours: 8**

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



**MCBACOR13P: MEDICAL MICROBIOLOGY (PRACTICAL)  
SEMESTER –VI**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Identify bacteria (any three of *E. coli*, *Staphylococcus*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Antibacterial sensitivity test by agar cup assay
3. Antibacterial sensitivity test by Kirby-Bauer method
4. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

**SUGGESTED READING**

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

**MCBACOR14T: RECOMBINANT DNA TECHNOLOGY (THEORY)  
SEMESTER –VI**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Introduction to Genetic Engineering**

**No. of Hours: 2**

Milestones in genetic engineering and biotechnology

**Unit 2 Molecular Cloning- Tools and Strategies**

**No. of Hours: 20**

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

**Unit 3 Methods in Molecular Cloning**

**No. of Hours: 16**

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

**Unit 4 DNA Amplification and DNA sequencing****No. of Hours: 10**

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

**Unit 5 Construction and Screening of Genomic & cDNA libraries No. of Hours: 6**

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****No. of Hours: 6**

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

**MCBACOR14P: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)  
SEMESTER –VI****TOTAL HOURS: 60****CREDITS: 2**

1. Preparation of competent cells for transformation
2. Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.

**SUGGESTED READING**

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

## **B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)**

### **MCBADSE01T: ADVANCES IN MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 60**  
**CREDITS: 4**

**Unit 1 Evolution of Bacterial Genomes** **No. of Hours: 15**  
Basic concept of bacterial genome evolution, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

**Unit 2 Metagenomics** **No. of Hours: 15**  
Development of metagenomics, Understanding bacterial diversity using metagenomic approach. Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

**Unit 3 Molecular Basis of Host-Microbe Interactions** **No. of Hours: 15**  
Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.

**Unit 4 Systems and Synthetic Biology** **No. of Hours: 15**  
Networking in biological systems: Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors. Introduction and implications of synthetic biology with respect to bacteria and viruses

### **MCBADSE01P: ADVANCES IN MICROBIOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**  
**CREDITS: 2**

1. Extraction and purification genomic DNA from *E.coli* using phenol chloroform method.
2. Performing PCR amplification by using suitable DNA
3. Isolation of antibiotic resistant bacteria from soil and study of multiple antibiotic resistance, using at least three(3) antibiotics.

#### **SUGGESTED READING**

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Benjamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011) Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,

9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, 1st edition, Garland Science

**MCBADSE02T: BIOMATHEMATICS AND BIOSTATISTICS (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Biomathematics**

**No of Hours: 30**

Reaction Kinetics: Zero order, first order, second order kinetics with examples; Michaelis-Menten equation; Coupled reactions, Application in fermentation technique: Mathematical expression in batch culture, continuous culture, steady state condition, logarithm: Application in Henderson-Hasselbatch equation, problems related to buffer solution, Free energy: Mathematical expression and related problems, Differentiation and Integration: Radioactive decay, Half life, problems related to radioactivity, Decimal reduction time: mathematical expression and related problems

**Unit 2 Biostatistics**

**No of Hours: 30**

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Poisson and Normal distribution  
 Statistical methods: Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors: Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; t-test, Z- test and F test; Confidence Interval; Chi-square test

**MCBADSE02P: BIOMATHEMATICS AND BIOSTATISTICS (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Mean, Median, Mode from grouped and ungrouped Data set
2. Determination of Standard Deviation and standard error in laboratory experiment data
3. Graphical representation of Standard Deviation and standard error
4. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
5. Determination of Confidence Interval by MPN test of water sample

**SUGGESTED READINGS**

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

**MCBADSE03T: INHERITANCE BIOLOGY  
(THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Introduction to Genetics**

**No. of Hours: 5**

Historical development, Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Arabidopsis thaliana*

**Unit 2 Mendelian Principles**

**No. of Hours: 13**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity

**Unit 3 Linkage and Crossing over**

**No. of Hours: 6**

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over.

**Unit 4 Extra-Chromosomal Inheritance**

**No. of Hours: 9**

Extra nuclear inheritance in bacteria: Plasmid and episome, Organelle heredity – Chloroplast, Mitochondria,

**Unit 5 Characteristics of Chromosomes**

**No. of Hours: 8**

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes,

**Unit 6 Recombination**

**No. of Hours: 7**

Homologous and non-homologous recombination, including transposition, site-specific recombination.

**Unit 7 Human genetics**

**No. of Hours: 12**

Pedigree analysis, lod score for linkage testing, karyotypes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

**MCBADSE03P: INHERITANCE BIOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Chi-Square Analysis of Mendelian monohybrid/dihybrid cross
2. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae
3. Study of pedigree analysis: problems

## SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9<sup>th</sup> Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

## MCBADSE04T: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)

**TOTAL HOURS: 60**

**CREDITS: 4**

### **Unit 1 Soil Microbiology**

**No of Hours: 9**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

### **Unit 2 Microbial Activity in Soil and Green House Gases**

**No of Hours: 6**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

### **Unit 3 Microbial Control of Soil Borne Plant Pathogens**

**No of Hours: 9**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects.

### **Unit 4 Biofertilization, Phytostimulation, Bioinsecticides**

**No of Hours: 16**

Plant growth promoting bacteria, biofertilizers – symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), Non Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae), Phosphate solubilizers.

### **Unit 5 Secondary Agriculture Biotechnology**

**No of Hours: 12**

Biomanure, biogas, biofuels – general concepts and advantages

### **Unit 6 Genetically Modified crops**

**No of Hours: 8**

Bt crops, golden rice, transgenic animals, advantages, social and environmental aspects.

## MCBADSE04P: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Study of microflora of rhizospheric soils
2. Isolation and characterization of phosphate solubilizing bacteria from soil
3. Isolation and characterization of Nitrogen fixing bacteria from soil
4. Isolation of *Rhizobium* from root nodules
5. Soil dehydrogenase assay

## SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4<sup>th</sup> edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, 1st edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

## **MCBADSE05T: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

### **Unit 1**

**No of Hours: 16**

Concept of IPR, Designs, trademarks, trade secrets, domain names, geographical indications, copyright, Evolution of patent laws, history of Indian patent system, Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Classification of patents in India,

### **Unit 2**

**No of Hours: 12**

classification of patents by WIPO, categories of patent, special patents, patenting biological products, Patentable inventions in India and abroad, non patentable inventions in India and abroad, Rights of patent holder and co-owners, transfer of patent rights, limitations of patent rights, Patent and economy, patent management, patent growth, patenting of life forms, biodiversity and IPR, Study of famous case study between Diamond and Chakraborty

**Unit 3****No of Hours: 12**

Overview of biosafety, risk assessment, Cartagena Protocol on Biosafety, capacity building, GMOs Transgenic technology, future opportunities and challenges, Regulatory measures for biosafety, biosafety guidelines in India evolved by DBT.

**Unit 4****No of Hours: 12**

Prevention of Food Adulteration Act, Food Safety and Standards Bill and Seed Policy, rules for the manufacture and storage of hazardous, biosafety management, Some of the products developed from RDT and their biosafety issues, biosafety and Gene therapy, ecological safety assessment of recombinant organisms

**Unit 5****No of Hours: 8**

Bioethics and its scope, different approaches to ethics, biological weapons and their social and ethical implications, Importance of good laboratory practices, general good laboratory practices

**MCBADSE05P: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS  
(PRACTICAL)**

**TOTAL HOURS: 60****CREDITS: 2**

Standardization of contamination free environment in laboratory practices. Biochemical and Microbiological analysis of Foods. Food adulteration and its Testing / Analysis

**Suggested Reading**

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson



**MCBADSE06T: INSTRUMENTATION AND BIOTECHNIQUES  
(THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Microscopy**

**No. of Hours: 10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy).

**Unit 2 Chromatography**

**No. of Hours: 14**

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

**Unit 3 Electrophoresis**

**No. of Hours: 14**

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

**Unit 4 Spectrophotometry**

**No. of Hours: 10**

Principle and use of study of absorption spectra of biomolecules, Analysis of biomolecules using UV and visible range, Colorimetry and turbidometry

**Unit 5 Centrifugation**

**No. of Hours: 12**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation

**MCBADSE06P : INSTRUMENTATION AND BIOTECHNIQUES  
(PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Separation of amino acid mixtures by thin layer chromatography.
2. Separation of protein mixtures by any form of chromatography.
3. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
4. Determination of  $\lambda_{\max}$  for an unknown sample and calculation of extinction coefficient.
5. Separation of components of a given mixture using a laboratory scale centrifuge.

**SUGGESTED READINGS**

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Ed., Cambridge University Press.

2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5<sup>th</sup> Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9<sup>th</sup>Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
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.

**MCBSSEC01M: FOOD  
FERMENTATION TECHNIQUES**

**TOTAL HOURS: 30**

**CREDITS: 2**

**Unit 1 Fermented Foods**

**No of Hours: 4**

Definition, types, advantages and health benefits

**Unit 2 Milk Based Fermented Foods**

**No of Hours: 8**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

**Unit 3 Grain Based Fermented Foods**

**No of Hours: 6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

**Unit 4 Vegetable Based Fermented Foods**

**No of Hours: 4**

Pickels, Saeurkraut: Microorganisms and production process

**Unit 5 Fermented Meat and Fish**

**No of Hours: 4**

Types, microorganisms involved, fermentation process

**Unit 6 Probiotic Foods**

**No of Hours: 4**

Definition, types, microorganisms and health benefits

**Suggested Readings**

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

## MCBSSEC02M: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

**TOTAL HOURS: 30**

**CREDITS: 2**

### **Unit 1 Aeromicrobiology**

**No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

### **Unit 2 Air Sample Collection and Analysis**

**No of Hours: 7**

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

### **Unit 3 Control Measures**

**No of Hours: 4**

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

### **Unit 4 Water Microbiology**

**No of Hours: 4**

Water borne pathogens, water borne diseases

### **Unit 5 Microbiological Analysis of Water**

**No of Hours: 7**

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

### **Unit 6 Control Measures**

**No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light

### **Suggested Reading**

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
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4<sup>th</sup> edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2<sup>nd</sup> edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3<sup>rd</sup> edition, ASM press edition, ASM press

MCBHGEC01T/ MCBGCOR01T(For General Students):

**BACTERIOLOGY AND VIROLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Cell organization**

**No. of Hours: 10**

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

**Unit 2 Bacterial growth and control**

**No. of Hours: 8**

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, phases of growth

**Unit 3 Bacterial Systematics and Taxonomy**

**No. of Hours: 8**

Taxonomy, nomenclature, systematics, types of classifications, Morphology, ecological significance and economic importance of Gram negative and Gram positive bacteria.

**Unit 4 Introduction to Viruses**

**No. of Hours: 12**

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**

**No. of Hours: 12**

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**

**No. of Hours: 10**

Viruses as pathogens: Role of viruses in causing diseases, Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

**MCBHGE01P/ MCBGCOR01P (For General Students):**

**BACTERIOLOGY AND VIROLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform 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

**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 Microorganisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th 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. 2nd edition. ASM Press

MCBHGEC02T/ MCBGCOR02T(For General Students):

## INDUSTRIAL & FOOD MICROBIOLOGY (THEORY)

**TOTAL HOURS: 60**

**CREDITS: 4**

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

**No. of Hours: 10**

Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous, Types of fermenters – laboratory, pilot-scale and production fermenters, Components of a typical continuously stirred tank bioreactor

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

**No. of Hours: 8**

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

### **Unit 3 Microbial fermentation processes**

**No. of Hours: 12**

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin, Industrial production and uses of the enzymes - amylases, proteases.

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

**No. of Hours: 9**

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

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

**No. of Hours: 9**

Physical methods - high temperature, low temperature, irradiation, aseptic packaging  
Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite  
Food sanitation and control – HACCP

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

**No. of Hours: 12**

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

MCBHGEC02P/ MCBGCOR02P (For General Students):

## INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Isolation of amylase producing bacteria from soil
2. Determination of the microbiological quality of milk sample by MBRT
3. Isolation of fungi from spoilt bread/fruits/vegetables
4. Preparation of Yogurt/Dahi

### **SUGGESTED READING**

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2<sup>nd</sup> Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education

**MCBHGE03T/ MCBGCOR03T (For General Students):**

**MICROBIAL GENETICS AND MOLECULAR BIOLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Structures of DNA and RNA / Genetic Material      No. of Hours: 6**

DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA in Prokaryotes.

**Unit 2 Replication of DNA      No. of Hours: 6**

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.

**Unit 3 Transcription      No. of Hours: 6**

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

**Unit 4 Translation      No. of Hours: 6**

Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

**Unit 5 Regulation of gene Expression      No. of Hours: 3**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* operon.

**Unit 6 Mutations      No. of Hours: 8**

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens.

**Unit 7 Modes of Genetic Exchange in bacteria      No. of Hours: 10**

Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains. Transduction - Generalized transduction, specialized transduction

**Unit 8 Introduction to genetic engineering      No. of Hours: 15**

Restriction modification systems: Type II restriction enzymes in genetic engineering, DNA modifying enzymes: DNA polymerases, Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases.

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series

PCR: Basics of PCR.

**MCBHGE03P/ MCBGCOR03P (For General Students):**

**MICROBIAL GENETICS & MOLECULAR BIOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Demonstration of transformation experiment in *E.coli*
2. Demonstration of Bacterial conjugation

**MCBHGEC04T/ MCBGCOR04T (For General Students):  
MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Normal microflora of the human body and host pathogen interaction**

**No. of Hours: 10**

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

**Unit 2 Bacterial diseases**

**No. of Hours: 4**

List of diseases of various organ systems and their causative agents. (Meningitis, tuberculosis, leprosy, cholera, diphtheria, whooping cough, tetanus)

**Unit 3 Viral diseases**

**No. of Hours: 3**

List of diseases of various organ systems and their causative agents. (polio, influenza, pox, mumps, measles, rubella)

**Unit 4 Protozoan diseases**

**No. of Hours: 2**

List of diseases of various organ systems and their causative agents.(Amoebic dysentery, malaria)

**Unit 5 Fungal diseases**

**No. of Hours: 3**

Brief description of various types of mycoses.

**Unit 6 Antimicrobial agents: General characteristics and mode of action**

**No. of Hours:10**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism, Antifungal agents: Amphotericin B, Griseofulvin, Antiviral agents: Amantadine, Acyclovir, Azidothymidine

**Unit 7 Immune Cells and Organs**

**No. of Hours: 8**

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

**Unit 8 Antigens and Antibodies**

**No. of Hours: 8**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T& B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

**Unit 9 Generation of Immune Response**

**No. of Hours: 6**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

**Unit 10 Immunological Techniques**

**No. of Hours: 6**

Principles of Precipitation, Agglutination, Immunodiffusion, Immuno-electrophoresis, ELISA



**MCBHGE04P/ MCBGCOR04P (For General Students):**  
**MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)**  
**TOTAL HOURS: 60** **CREDITS: 2**

1. Identify bacteria on the basis of biochemical characteristics: IMViC, nitrate reduction, urease production and catalase tests
2. Perform antibacterial sensitivity by Kirby-Bauer method
3. Identification of human blood groups.
4. To perform immunodiffusion by Ouchterlony method.

**SUGGESTED READING**

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

**WEST BENGAL STATE UNIVERSITY**  
**CBCS DRAFT SYLLABUS**  
**FOR**  
**THREE-YEAR MICROBIOLOGY GENERAL**  
**DEGREE COURSE OF STUDIES**

Distribution of courses in different semesters for Undergraduate course in **MICROBIOLOGY**

**GENERAL**

Semester	Core	DSE	GE	AECC	SEC	Total credit
I	MCBGCOR01T/P			Environmental Science		20
II	MCBGCOR02T/P			English/MIL Communication		20
III	MCBGCOR03T/P				MCBSSEC01M	20
IV	MCBGCOR04T/P				MCBSSEC02M	20
V		MCBGDSE01T/P MCBGDSE02T/P (Any one)			XSSEC03M	20
VI		MCBGDSE03T/P MCBGDSE04T/P (Any one)			XSSEC04M	20
Total number of courses	12	6	0	2	4	120

X – FROM OTHER DISCIPLINE

MCBGCOR01T(For General Students):

## **BACTERIOLOGY AND VIROLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

### **Unit 1 Cell organization**

**No. of Hours: 10**

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

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

**No. of Hours: 8**

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, phases of growth

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

**No. of Hours: 8**

Taxonomy, nomenclature, systematics, types of classifications, Morphology, ecological significance and economic importance of Gram negative and Gram positive bacteria.

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

**No. of Hours: 12**

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**

**No. of Hours: 12**

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**

**No. of Hours: 10**

Viruses as pathogens: Role of viruses in causing diseases, Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

**MCBGCOR01P** (For General Students):

**BACTERIOLOGY AND VIROLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform 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

**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 Microorganisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th 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.2nd edition.ASM Press

**MCBGCOR02T(For General Students):**

**INDUSTRIAL & FOOD MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Introduction to Industrial microbiology**

**No. of Hours: 10**

Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous, Types of fermenters – laboratory, pilot-scale and production fermenters, Components of a typical continuously stirred tank bioreactor

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

**No. of Hours: 8**

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

**Unit 3 Microbial fermentation processes**

**No. of Hours: 12**

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin, Industrial production and uses of the enzymes - amylases, proteases.

**Unit 4 Food as a substrate for microbial growth**

**No. of Hours: 9**

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

**Unit 5 Principles and methods of food preservation and food sanitation**

**No. of Hours: 9**

Physical methods - high temperature, low temperature, irradiation, aseptic packaging  
Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite  
Food sanitation and control – HACCP

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

**No. of Hours: 12**

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

**MCBGCOR02P (For General Students):**

**INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Isolation of amylase producing bacteria from soil
2. Determination of the microbiological quality of milk sample by MBRT
3. Isolation of fungi from spoilt bread/fruits/vegetables
4. Preparation of Yogurt/Dahi

**SUGGESTED READING**

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2<sup>nd</sup> Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education

**MCBGCOR03T (For General Students):**

**MICROBIAL GENETICS AND MOLECULAR BIOLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Structures of DNA and RNA / Genetic Material      No. of Hours: 6**

DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA in Prokaryotes.

**Unit 2 Replication of DNA      No. of Hours: 6**

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.

**Unit 3 Transcription      No. of Hours: 6**

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

**Unit 4 Translation      No. of Hours: 6**

Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

**Unit 5 Regulation of gene Expression      No. of Hours: 3**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* operon.

**Unit 6 Mutations      No. of Hours: 8**

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens.

**Unit 7 Modes of Genetic Exchange in bacteria      No. of Hours: 10**

Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains. Transduction - Generalized transduction, specialized transduction

**Unit 8 Introduction to genetic engineering      No. of Hours: 15**

Restriction modification systems: Type II restriction enzymes in genetic engineering, DNA modifying enzymes: DNA polymerases, Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases.

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series

PCR: Basics of PCR.

**MCBGCOR03P (For General Students):**

**MICROBIAL GENETICS & MOLECULAR BIOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Demonstration of transformation experiment in *E.coli*
2. Demonstration of Bacterial conjugation

**MCBGCOR04T (For General Students):  
MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Normal microflora of the human body and host pathogen interaction**

**No. of Hours: 10**

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

**Unit 2 Bacterial diseases**

**No. of Hours: 4**

List of diseases of various organ systems and their causative agents. (Meningitis, tuberculosis, leprosy, cholera, diphtheria, whooping cough, tetanus)

**Unit 3 Viral diseases**

**No. of Hours: 3**

List of diseases of various organ systems and their causative agents. (polio, influenza, pox, mumps, measles, rubella)

**Unit 4 Protozoan diseases**

**No. of Hours: 2**

List of diseases of various organ systems and their causative agents.(Amoebic dysentery, malaria)

**Unit 5 Fungal diseases**

**No. of Hours: 3**

Brief description of various types of mycoses.

**Unit 6 Antimicrobial agents: General characteristics and mode of action**

**No. of Hours:10**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism, Antifungal agents: Amphotericin B, Griseofulvin, Antiviral agents: Amantadine, Acyclovir, Azidothymidine

**Unit 7 Immune Cells and Organs**

**No. of Hours: 8**

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

**Unit 8 Antigens and Antibodies**

**No. of Hours: 8**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T& B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

**Unit 9 Generation of Immune Response**

**No. of Hours: 6**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

**Unit 10 Immunological Techniques**

**No. of Hours: 6**

Principles of Precipitation, Agglutination, Immunodiffusion, Immuno-electrophoresis, ELISA



**MCBGCOR04P (For General Students):**

**MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Identify bacteria on the basis of biochemical characteristics: IMViC, nitrate reduction, urease production and catalase tests
2. Perform antibacterial sensitivity by Kirby-Bauer method
3. Identification of human blood groups.
4. To perform immunodiffusion by Ouchterlony method.

**SUGGESTED READING**

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

**DSE FOR B.Sc. GENERAL PROGRAMME:**

**MCBGDSE01T: INSTRUMENTATION AND BIOTECHNIQUES  
(THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Microscopy**

**No. of Hours: 10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy).

**Unit 2 Chromatography**

**No. of Hours: 14**

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

**Unit 3 Electrophoresis**

**No. of Hours: 14**

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

**Unit 4 Spectrophotometry**

**No. of Hours: 10**

Principle and use of study of absorption spectra of biomolecules, Analysis of biomolecules using UV and visible range, Colorimetry and turbidometry

### **Unit 5 Centrifugation**

**No. of Hours: 12**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation

## **MCBGDSE01P : INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Separation of amino acid mixtures by thin layer chromatography.
2. Separation of protein mixtures by any form of chromatography.
3. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
4. Determination of  $\lambda_{\text{max}}$  for an unknown sample and calculation of extinction coefficient.
5. Separation of components of a given mixture using a laboratory scale centrifuge.

### **SUGGESTED READINGS**

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5<sup>th</sup> Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9<sup>th</sup> Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
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.

**MCBGDSE02T: INHERITANCE BIOLOGY  
(THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Introduction to Genetics**

**No. of Hours: 5**

Historical development, Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Arabidopsis thaliana*

**Unit 2 Mendelian Principles**

**No. of Hours: 13**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance.

**Unit 3 Linkage and Crossing over**

**No. of Hours: 6**

Linkage and recombination of genes, Cytological basis of crossing over.

**Unit 4 Extra-Chromosomal Inheritance**

**No. of Hours: 9**

Extra nuclear inheritance in bacteria: Plasmid and episome, Organelle heredity – Chloroplast, Mitochondria,

**Unit 5 Characteristics of Chromosomes**

**No. of Hours: 8**

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes,

**Unit 6 Recombination**

**No. of Hours: 7**

Homologous and non-homologous recombination, including transposition, site-specific recombination.

**Unit 7 Human genetics**

**No. of Hours: 12**

Karyotyping and genetic disorders: Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

**MCBGDSE02P: INHERITANCE BIOLOGY (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Chi-Square Analysis of Mendelian monohybrid/dihybrid cross
2. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae

**SUGGESTED READING**

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education

4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9<sup>th</sup> Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

**MCBGDSE03T: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

**Unit 1 Soil Microbiology**

**No of Hours: 9**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

**Unit 2 Microbial Activity in Soil and Green House Gases**

**No of Hours: 6**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

**Unit 3 Microbial Control of Soil Borne Plant Pathogens**

**No of Hours: 9**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects.

**Unit 4 Biofertilization, Phytostimulation, Bioinsecticides**

**No of Hours: 16**

Plant growth promoting bacteria, biofertilizers – symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), Non Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae), Phosphate solubilizers.

**Unit 5 Secondary Agriculture Biotechnology**

**No of Hours: 12**

Biomanure, biogas, biofuels – general concepts and advantages

**Unit 6 Genetically Modified crops**

**No of Hours: 8**

Bt crops, golden rice, transgenic animals, advantages, social and environmental aspects.

**MCBGDSE03P: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Study of microflora of rhizospheric soil different types of soils
2. Isolation and characterization of phosphate solubilizing bacteria from soil
3. Isolation and characterization of Nitrogen fixing bacteria from soil
4. Isolation of *Rhizobium* from root nodules
5. Soil dehydrogenase assay

## **SUGGESTED READINGS**

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4<sup>th</sup> edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, 1st edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

## **MCBGDSE04T: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)**

**TOTAL HOURS: 60**

**CREDITS: 4**

### **Unit 1**

**No of Hours: 16**

Concept of IPR, Designs, trademarks, trade secrets, domain names, geographical indications, copyright, Evolution of patent laws, history of Indian patent system, Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement;

WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms;

UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent

amendments. Classification of patents in India,

### **Unit 2**

**No of Hours: 12**

classification of patents by WIPO, categories of patent, special patents, patenting biological products, Patentable inventions in India and abroad, non patentable inventions in India and abroad, Rights of patent holder and co-owners, transfer of patent rights, limitations of patent rights.

### **Unit 3**

**No of Hours: 12**

Overview of biosafety, risk assessment, Cartagena protocol on biosafety, capacity building, GMOs Transgenic technology, future opportunities and challenges, Regulatory measures for biosafety, biosafety guidelines in India evolved by DBT.

### **Unit 4**

**No of Hours: 12**

Prevention food adulteration act, food and safety standard bill and seed policy, rules for the manufacture and storage of hazardous, biosafety management, Some of the products development from RDT and their biosafety issues, biosafety and Gene therapy, ecological safety assessment of recombinant organisms

### **Unit 5**

**No of Hours: 8**

Bioethics and its scope, different approaches to ethics, biological weapons and their social and ethical implications, Importance of good laboratory practices, general good laboratory practices

**MCBGDSE04P: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS  
(PRACTICAL)**

**TOTAL HOURS: 60**

**CREDITS: 2**

Standardization of contamination free environment in laboratory practices. Biochemical and Microbiological analysis of Foods. Food adulteration and its Testing / Analysis

**Suggested Reading**

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

**SEC COURSES FOR B.SC GENERAL PROGRAMME IN MICROBIOLOGY**

**MCBSSEC01M: FOOD  
FERMENTATION  
TECHNIQUES**

**TOTAL HOURS: 30  
CREDITS: 2**

<b>Unit 1 Fermented Foods</b>	<b>No of Hours: 4</b>
Definition, types, advantages and health benefits	
<b>Unit 2 Milk Based Fermented Foods</b>	<b>No of Hours: 8</b>
Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process	
<b>Unit 3 Grain Based Fermented Foods</b>	<b>No of Hours: 6</b>
Soy sauce, Bread, Idli and Dosa: Microorganisms and production process	
<b>Unit 4 Vegetable Based Fermented Foods</b>	<b>No of Hours: 4</b>
Pickels, Saeurkraut: Microorganisms and production process	
<b>Unit 5 Fermented Meat and Fish</b>	<b>No of Hours: 4</b>
Types, microorganisms involved, fermentation process	

## **Unit 6 Probiotic Foods**

**No of Hours: 4**

Definition, types, microorganisms and health benefits

### **Suggested Readings**

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

## **MCBSSEC02M: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER**

**TOTAL HOURS: 30**

**CREDITS: 2**

### **Unit 1 Aeromicrobiology**

**No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

### **Unit 2 Air Sample Collection and Analysis**

**No of Hours: 7**

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

### **Unit 3 Control Measures**

**No of Hours: 4**

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

### **Unit 4 Water Microbiology**

**No of Hours: 4**

Water borne pathogens, water borne diseases

### **Unit 5 Microbiological Analysis of Water**

**No of Hours: 7**

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

### **Unit 6 Control Measures**

**No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light

### **Suggested Reading**

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



2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications.  
4<sup>th</sup> edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2<sup>nd</sup> edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3<sup>rd</sup> edition, ASM press edition, ASM press