NEW
CBCS SYLLABUS

FOR

THREE YEARS UNDER-GRADUATE COURSE

IN

MICROBIOLOGY (HONOURS)

(w.e.f. 2022-2023)

BANKURA UNIVERSITY

BANKURA

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CONTENTS

1. INTRODUCTION

The syllabus for Microbiology at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC. The main objective of framing this new syllabus is to give the students a holistic understandingof the subject giving substantial weightage to both the core content and techniques used in Microbiology. The ultimate goal of the syllabus is that the students at the end are able to secure a job. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques of mapping and understanding of the subject. The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

It is essential that Microbiology students select their generic electives courses Chemistry as compulsory and any one from the branch of Life Sciences disciplines. While the syllabus is in compliance with UGC model curriculum, it is necessary that Microbiology students should learn "Bioinformatics, Microbes in Sustainable Agriculture and Development & Instrumentation and Biotechniques" as one of the core courses rather than as elective while.

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

PROGRAM OUTCOME (PO)		
PO	**Summary**	**Description**
PO A:	Sound Domain Knowledge	Acquiring a strong, basic knowledge on origin, evolution and diversification in the applied field of Microbiology.
PO B:	Laboratory Skill	To develop good laboratory skills with latest advanced tools, sophisticated instruments and modern technologies to address emerging problems with scientific viewpoint.
PO C:	Team Work	To develop the spirit of teamwork, learn to harbor collaborative approach to explore new facts and facets of the subject.
PO D:	Academic and Scientific Endeavour	Students will gain cognitive development, innovative approach, technical maneuvering, entrepreneurship and managerial skills to set up a new start-up.
PO E:	Eco-friendly Approach	Futuristic approach to develop eco-friendly management practices to make socio-economic upliftment.
PO F:	Ethical Awareness	To develop ethical awareness among students regarding research & publications.
PO G:	Goal of life	To inculcate visions in students so that they can play a vital role for the advancement of the discipline in the greater benefits of the society.
PROGRAM SPECIFIC OUTCOME (PSO)		
PSO	Summary	Description
PSO1:	Rational analysis	Develops fundamental concepts, rational thinking & analytical skill.
PSO2:	Soft Skill Proficiency	Develops communication skill, attitudes, leadership quality, ethical values and social awareness.
PSO3:	Environmental Consciousness	Increases eco-friendly consciousness, waste-management practices.
PSO4:	Hygiene practices	Builds up good habit of hygienic practices.
PSO5:	Scientific attitude	Inculcates research mind & approach to develop eco-friendly bio-products.
PSO6:	Resource management	Develops the knowledge & skill on natural & renewable resource management.
PSO7:	Dry lab practices	Develops ability of sequence analysis & structure prediction.
PSO8:	Awareness against infectious diseases	Develops Awareness against infectious & fatal diseases.
PSO9:	Ecological Awareness	Develops Ecological Awareness among students through Mushroom diversity study in different forest areas of the district.
PSO10:	Skill Development	Students will gain knowledge through different Hands-on-training program on Agro-economic activities.
PSO11:	Social Interaction	Develops Community link up through regular survey on Health & Nutritional parameters of local villagers.
PSO12:	Ethno-medicinal Practices	Develops knowledge on Ethno-medicinal Plants, their commercial usage & worldwide applications.

2. Scheme for CBCS Curriculum

Credit Distribution across Courses

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

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

Note:

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

Scheme for CBCS Curriculum

SEMESTER	COURSE	COURSE DETAIL	CREDITS
I	Core course – 1	Introduction to Microbiology and Microbial Diversity	4
	Core course – 1 (Practical)	Introduction to Microbiology and Microbial Diversity	2
	Core course – 2	Bacteriology	4
	Core course – 2 (Practical)	Bacteriology	2
	Generic Elective – 1	Introduction and Scope of Microbiology	4
	Generic Elective – 1 (Practical)	Introduction and Scope of Microbiology	2
	Ability Enhancement Compulsory Course – 1	Environmental Studies (ENVS)	2
II	Core course – 3	Biochemistry	4
	Core course – 3 (Practical)	Biochemistry	2
	Core course – 4	Virology	4
	Core course – 4 (Practical)	Virology	2
	Generic Elective – 2	Bacteriology and Virology	4
	Generic Elective – 2 (Practical)	Bacteriology and Virology	2
	Ability Enhancement Compulsory Course – 2	English/ Hindi/ MIL	2
III	Core course – 5	Microbial Physiology and Metabolism	4
	Core course – 5 (Practical)	Microbial Physiology and Metabolism	2
	Core course – 6	Cell Biology	4
	Core course – 6 (Practical)	Cell Biology	2
	Core course – 7	Molecular Biology	4
	Core course – 7 (Practical)	Molecular Biology	2
	Skill Enhancement Course – 1	Microbial Diagnosis in Health Clinics / Management of Human Microbial Diseases	2
	Generic Elective – 3	Microbial Metabolism	4
	Generic Elective – 3 (Practical)	Microbial Metabolism	2
IV	Core course – 8	Microbial Genetics	4
	Core course – 8 (Practical)	Microbial Genetics	2
	Core course – 9	Environmental Microbiology	4
	Core course – 9 (Practical)	Environmental Microbiology	2
	Core course – 10	Food and Dairy Microbiology	4
	Core course – 10 (Practical)	Food and Dairy Microbiology	2
	Skill Enhancement Course-2	Food Fermentation Techniques/ Microbiological Analysis of Air and Water	2

	Generic Elective – 4	Medical Microbiology and Immunology	4
	Generic Elective – 4 (Practical)	Medical Microbiology and Immunology	2
V	Core course – 11	Industrial Microbiology	4
	Core course – 11 (Practical)	Industrial Microbiology	2
	Core course – 12	Immunology	4
	Core course – 12 (Practical)	Immunology	2
	Discipline Specific Elective – 1	Instrumentation and Biotechniques/ Inheritance Biology	4
	Discipline Specific Elective – 1 (Practical)	Instrumentation and Biotechniques/ Inheritance Biology	2
	Discipline Specific Elective – 2	Dissertation Work with Seminar	6
VI	Core course – 13	Medical Microbiology	4
	Core course – 13 (Practical)	Medical Microbiology	2
	Core course – 14	Recombinant DNA Technology	4
	Core course – 14 (Practical)	Recombinant DNA Technology	2
	Discipline Specific Elective – 3	Microbes in Sustainable Agriculture and Development/ Plant Pathology	4
	Discipline Specific Elective – 3 (Practical)	Microbes in Sustainable Agriculture and Development/ Plant Pathology	2
	Discipline Specific Elective – 4	Bioinformatics/ Biomathematics and Biostatistics	4
	Discipline Specific Elective – 4 (Practical)	Bioinformatics/ Biomathematics and Biostatistics	2

Choices for Discipline Specific Elective

DSE-1	**SEM-V**	Any one from: 1. Instrumentation and Biotechniques 2. Inheritance Biology
DSE-2		Dissertation Work with Seminar
DSE-3	**SEM-VI**	Any one from: 3. Microbes in Sustainable Agriculture and Development 4. Plant Pathology
DSE-4		Any one from: 5. Bioinformatics 6. Biomathematics and Biostatistics

Choices for Skill Enhancement Courses

SEC-1	**SEM-III**	Any one from: 1. Microbial Diagnosis in Health Clinics 2. Management of Human Microbial Diseases
SEC-2	**SEM-IV**	Any one from: 3. Food Fermentation Techniques 4. Microbiological Analysis of Air and Water

Scheme for CBCS Curriculum in Microbiology (Honours)

SEMESTER –I

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
SH/MCB/101/C-1	Introduction to Microbiology and Microbial Diversity	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/102/C-2	Bacteriology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/ MCB /103/GE-1	Introduction and scope of Microbiology (For students of other discipline)	6 (T 4+P 2)	10	40 (T 25+P 15)	50
AECC 1	ENVS	4	10	40	50

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week

SEMESTER –II

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
SH/MCB/201/C-3	Biochemistry	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/202/C-4	Virology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/ MCB /203/GE-2	MICROBIOLOGY: Bacteriology and Virology (For students of other discipline)	6 (T 4+P 2)	10	40 (T 25+P 15)	50
AECC 2	English/Hindi/MIL	4	10	40	50

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week

SEMESTER –III

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
SH/MCB/ 301/C-5	Microbial Physiology and Metabolism	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/ 302/ C-6	Cell Biology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/ 303/C-7	Molecular Biology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/ MCB /304/GE-3	Microbial Metabolism	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/ 305/SEC-1	Any one from: 1. Microbial Diagnosis in Health Clinics 2. Management of Human Microbial Diseases	2 (P)	10	40 P	50

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week

SEMESTER –IV

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
SH/MCB/ 401/C-8	Microbial Genetics	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/ 402/ C-9	Environmental Microbiology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/ 403/C-10	Food and Dairy Microbiology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/ MCB /404/GE-4	MICROBIOLOGY : Medical Microbiology and Immunology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/ 405/SEC-2	Any one from: 1. Food Fermentation Techniques 2. Microbiological Analysis of Air and Water	2 (P)	10	40 P	50

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week

SEMESTER –V

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
SH/MCB/501/C-11	Industrial Microbiology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/502/C-12	Immunology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/503/DSE-1	Any one from: 1. Instrumentation and Biotechniques 2. Inheritance Biology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/504/DSE-2	Dissertation Work with Seminar	6	10	40	50

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week

SEMESTER –VI

Course Code	Course Title	Credit	Marks		
			I.A.	ESE	Total
SH/MCB/601/C-13	Medical Microbiology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/602/C-14	Recombinant DNA Technology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/603/DSE-3	Any one from: 1. Microbes in Sustainable Agriculture and Development 2. Plant Pathology	6 (T 4+P 2)	10	40 (T 25+P 15)	50
SH/MCB/604/DSE-4	Any one from: 1. Bioinformatics 2. Biomathematics and Biostatistics	6 (T 4+P 2)	10	40 (T 25+P 15)	50

N.B. Theory:- 1 Credit= 1 hour/Week, Practical:- 1 Credit= 2 hours/Week

[SH=Science Honours, MCB = Microbiology, C= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GE= Generic Elective, DSE= Discipline Specific Elective, IA= Internal Assessment, ESE= End- Semester Examination, Lec.=Lecture, and P=Practical]

Question Pattern

Core and DSE papers (Theory F.M: 25 & Practical F.M: 15)

Theory	F.M: 25	Practical	F.M: 15
UNIT-I		1.Work out/Demonstration/Experiment:	10/9
1. Any five out of eight	5×1=5		
UNIT-II		2.Laboratory Record/ Field Report:	2/3
2. Any two out of four	2×5=10	3.Viva Voce:	3
UNIT-III			
3. Any one out of two	1×10=10		

SEC papers (Theory F.M: 40)

Practical	F.M: 40
1.Work out (Major):	15
2. Work out (Minor)/ Demonstration:	10
3. Laboratory Record/ Field Report:	5
4.Viva Voce:	10

Core Courses

Semester – I

Core Course T1: Introduction to Microbiology and Microbial Diversity

Course Code: SH/MCB/101/C-1

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- The students will gain a holistic concept on history, development, scope and aspects of Microbiology. They will also learn about the contributions of Microbiologists.
- Students learn about the diversity of microbial world, kingdom and domain concept; features of dark field-, phase contrast- & electron microscopes.
- Students will achieve knowledge on habitat, distribution, nutritional requirements, ultra-structure, thallus organization and aggregation of algae and fungi.
- Students will gain knowledge on General characteristics & Economic importance of Protozoa.
- Students will be made aware of biosafety protocols and laboratory management.

Unit 1 History and Development of Microbiology	**No. of Hours: 15**
History, Development and Scope of microbiology Theory of Spontaneous generation, Germ theory of disease Contributions of Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich, Martinus W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology	
Unit 2 Diversity of Microbial World	**No. of Hours: 5**
Systems of classification: Basic idea about Hackel and Whittaker's kingdom concept and domainconcept of Carl Woese General characteristics and representative members of different groups: Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa). Acellular microorganisms (Viruses, Viroids, Prions).	
Unit 3 Basic Microscopy	**No. of Hours: 5**
Principle of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope.	
Unit 4 Phycology	**No. of Hours: 15**
General characteristics of algae including occurrence, thallus organization, cell ultrastructure, pigments, flagella, eye spot, food reserves and vegetative, asexual and sexual reproduction. General characters of the following classes:Chlorophyta, Xanthophyta, Cyanophyta. Applications of algae in agriculture, industry, environment and food.	

Unit 5 Mycology	**No. of Hours: 15**

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure, Different fruiting bodies, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanisms.

General characters of the following classes: Phycomycetes, Ascomycetes, Basidiomycetes & Deuteromycetes.

Economic importance of fungi in agriculture, medicine, food and Industry.

Unit 6 Protozoa	**No. of Hours: 5**

General characteristics with special reference to *Amoeba, Paramecium, Plasmodium*

Economic importance of Protozoa.

Reference Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition.
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. PearsonEducation Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGrawHill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

Core Course PI: Introduction to Microbiology and Microbial Diversity

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Microbiology Laboratory Management and Biosafety
2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuge, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media (Nutrient Broth an Nutrient Agar) for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven
6. Sterilization of heat sensitive material by filtration
7. Motility test by hanging drop method.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using permanent mounts
9. Study of *Spirogyra*, *Chlamydomonas* using permanent Mounts
10. Study of *Paramecium*, *Plasmodium* using permanent mounts

CORE COURSE T2: BACTERIOLOGY

Course Code: SH/MCB/102/C-2

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students get a prominent knowledge on detailed cell organization, arrangement and other characteristic features of a bacterial cell.
- Students learn about various physical & chemical methods of microbial control.
- Students will learn about bacterial growth, nutrition, motility and reproduction processes.
- Students perform pure cultures techniques to isolate, study, identify and preserve bacterial strains.

Unit 1 Cell organization	**No. of Hours: 14**
Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell- wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Differences between eubacteria and archaebacteria. Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.	
Unit 2 Bacteriological techniques	**No. of Hours: 5**
Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/ stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.	
Unit 3 Growth and nutrition	**No. of Hours: 6**
Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched media and enrichment technique. Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, antibiotics: types and mode of action.	
Unit 4 Reproduction in Bacteria	**No. of Hours: 8**
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture. Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.	
Unit 5 Important archaeal and eubacterial groups	**No. of Hours: 19**
Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain. **Archaebacteria**: General characteristics, suitable example and economic importance.	

Eubacteria: General characteristics with suitable example.

Gram Negative:

Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Delta proteobacteria, Epsilonproteobacteria, Zeta proteobacteria.

Gram Positive:

Low G+ C (Firmicutes), High G+C (Actinobacteria).

***Cyanobacteria*:** An Introduction

Unit 6 Culture preservation techniques **No. of Hours: 8**

Short-term preservation methods: Slant, Stab, Oil immersion,

Long-term preservation methods: Lyophilization, Cryopreservation

Reference Books

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J.Prentice Hall International, Inc.
4. PelczarJr 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 editionMcMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition PearsonEducation.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. PearsonEducation Limited

Core Course P2: Bacteriology

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Preparation of different media: Complex media-Nutrientagar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Endospore staining.
7. Isolation of pure cultures of bacteria from soil/ water by streak plate, pour plate and spread plate method.
8. Preservation of bacterial cultures (slant / stab).
9. Isolation and enumeration of bacteria from air

Semester - II

CORE COURSE T3: BIOCHEMISTRY

Course Code: SH/MCB/201/C-3

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- The students come to know about Bioenergetics.
- Students learn about properties, classification, stereo isomerism, Haworth projection of carbohydrates.
- Students learn about classification, structures and properties of fatty acids.
- Students gain knowledge on structures & Functions of proteins, Zwitterions.
- Students become capable of drawing Titration curve of amino acid.
- Students learn about Classification, Michaelis-Menten equation, induced fit hypothesis & mechanism of action of enzymes.
- Students perform Qualitative & Quantitative estimation of carbohydrates, amino acids, proteins, DNA and RNA.
- Students study about enzyme kinetics.

Unit 1 Physicochemical Properties of water	**No. of Hours: 5**
Tetra-hedron structure of water molecule, physical properties, ionic product of water, pH & pK – their definition, relation to acids, bases & buffers in biological system. Electrostatic bond, hydrogen bond, hydrophobic bonds & Van der Wall's interactions.	
Unit 2 Bioenergetics	**No. of Hours: 5**
First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenol pyruvate, ATP.	
Unit 3 Carbohydrates	**No. of Hours: 10**
General properties, classification of carbohydrates, families of monosaccharides: structural concept of aldoses and ketoses, trioses, tetroses, pentoses, and hexoses (glucose and fructose). Stereo isomerismof monosaccharides, epimers and anomers of glucose, Mutarotation, optical isomerism. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose and peptidoglycan.	
Unit 4 Lipids	**No. of Hours: 10**
Fatty acids: definition, types, structures and functions, essential fatty acids. Lipid: definition, nomenclature and classification (triacylglycerols, phosphoglycerides, phosphatidylethanolamine, phosphatidylcholine, sphingosine, ceramide, sphingomyelins, cerebrosides and gangliosides) with	

structures and properties. Functions of lipid. Introduction of lipid micelles, monolayers, bilayers.

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

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Classification, biochemical structure and notation of standard protein amino acids. Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the betapleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Human haemoglobin structure, Quaternary structures of Proteins.

Unit 6. Enzymes **No. of Hours: 10**

Structure of enzyme: Apoenzyme, coenzyme and cofactors.

Classification of enzymes, Mechanism of action of enzymes: active site, specificity, enzyme kinetics, Michaelis-Menten equation and their transformations, Km and allosteric mechanism, Lock and key hypothesis, and Induced Fit hypothesis.

Factors of enzyme activity: pH, temperature, substrate concentration, enzyme concentration, time.

Inhibitors: competitive; non-competitive, Un-competitive.

Unit 7. Vitamins and Nucleic Acids **No. of Hours: 10**

Classification and characteristics of with suitable examples, sources and importance. (Vitamin A, B, C, D, E & K). Purine and pyrimidine bases, nucleoside, nucleotide-structure, properties. Types of DNA and RNA.

Reference Books

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

CORE COURSE P3: BIOCHEMISTRY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

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

Core Course T4: Virology

Course Code: SH/MCB/202/C-4

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- The students come to know about Bioenergetics.
- Students can have the knowledge about capsid symmetry, isolation, purification and cultivation of viruses.
- Students came to know about early and late proteins in maintaining lytic and lysogenic cycle of T4/T2 phage.
- Students will have a thorough understanding on structure, nucleic acid, replication and symptoms of viruses.
- Students will have a broad idea about oncogenic DNA and RNA viruses.
- Students will be acquainted with Gene expression & Gene therapy.

Unit 1: Nature and Properties of Viruses	**No. of Hours: 12**
Introduction: Discovery of viruses, nature and definition of viruses, general properties Concept of virusoids, and satellite viruses Structure of Viruses: Symmetry, enveloped and non-enveloped virus. Isolation, purification and cultivation of viruses. Viral taxonomy: Baltimore Classification and nomenclature of different groups of viruses.	
Unit 2: Bacteriophages	**No. of Hours: 10**
Diversity, classification, lytic and lysogenic cycle of T4/T2 phage. Lysogenic to lytic switch over mechanism.	
Unit 3: Viral Transmission, Salient features of viral nucleic acids and	**No. of Hours: 20**
Structure, transmission, replication symptoms and treatment of: Adenovirus, Hepatitis B virus, Influenza virus, HIV, SARS-CoV-2.	
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: 8**
Antiviral compounds and their mode of actions Interferon and their mode of action General principles of viral vaccination	
Unit 6: Applications of Virology	**No. of Hours: 4**
Use of viral vectors in cloning and expression, Gene therapy and Phage display.	

Reference Books

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

2. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc

3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

Core Course P4: Virology

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Study of the structure of important animal viruses (Rhabdo and Retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (TMV, Cucumber Mosaic Viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Report a visit to any educational Institute/ Industry

Semester - III

CORE COURSE T5: MICROBIAL PHYSIOLOGY AND METABOLISM

Course Code: SH/MCB/ 301/C-5

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will be acquainted with carbohydrate metabolism and electron transport system.
- Students can have brief idea about Passive and facilitated diffusion & Nutrient uptake procedure.
- Students will analysis effect of temperature, pH & NaCl on bacterial growth.

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth	**No. of Hours: 10**
Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy (Definition with example only) – Autotroph/Phototroph, heterotroph, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.	
Unit 2 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 3 Chemoheterotrophic Metabolism - Aerobic Respiration	**No. of Hours: 12**
Concept of aerobic respiration. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Glyoxylate cycle, TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation.	
Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation	**No. of Hours: 6**
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 (homo fermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways.	
Unit 5 Chemolithotrophic and Phototrophic Metabolism	**No. of Hours: 10**
Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic Photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria.	

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

Introduction to biological nitrogen fixation.

Ammonia assimilation.

Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

Unit 7 Amino acid and Lipid Metabolism	No. of Hours: 6

Endo- and exo-peptidase, Transamination, Deamination, Transmethylation and decarboxylation. General idea about biosynthesis of amino acid

Beta-oxidation of even and odd number, saturated and unsaturated fatty acids, General idea about biosynthesis and degradations of fatty acids.

Reference Books

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

Core Course P5: Microbial Physiology and Metabolism

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods. Calculations of generation time and specific growth rate
2. Effect of temperature, pH and salt on growth of *E. coli*
3. Effect of carbon and nitrogen sources on growth of *E.coli*
4. Demonstration of the thermal death time and decimal reduction time of *E. coli.*
5. Demonstration of Di-auxic growth of *E. Coli*
6. Biochemical Tests: Catalase, Protease, Amylase, IMViC, and nitrate reduction test.
7. Sugar Fermentation Test

CORE COURSE T6: CELL BIOLOGY

Course Code: SH/MCB/ 302/ C-6

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will learn about the structure & organization of cell, protein sorting and transport.
- Students will know about different cell signaling pathways & their interconnections.
- Students will learn about advanced & core scientific research areas like regulation of programmed cell death, development of cancer, Stem cells.

Unit 1 Structure and organization of Cell	**No. of Hours: 12**
Cell Organization – Eukaryotic and prokaryotic Plasma membrane: Structure and transport of small molecules Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments	
Unit 2 Nucleus	**No. of Hours: 6**
Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin –Molecular organization Nucleolus	
Unit 3 Protein Sorting and Transport	**No. of Hours: 12**
Ribosomes Endoplasmic Reticulum – Structure and Functions Golgi Apparatus – Organization, protein glycosylation, and Functions Lysosomes	
Unit 4 Cell Signaling	**No. of Hours: 18**
Modes of Cell to Cell Signaling Signaling molecules and their receptorsFunction of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP Kinase pathway	
Unit 5 Cell Cycle, Cell Death and Cell Renewal	**No. of Hours: 12**
Regulation of Programmed cell death Development of cancer, causes and types, p53 gene product Stem cells, Embryonic stem cell, induced pleuripotent stem cells	

Reference Books

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.

2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley&Sons. Inc.

3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition.

LipincottWilliams and Wilkins, Philadelphia.

4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

CORE COURSE P6: CELL BIOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Study a representative plant cell by microscopy

2. Perform Total Leukocyte Count of the given blood sample

3. Study of the structure of cell organelles through electron micrographs

4. Identification of different stages of Mitosis (permanent slides)

5. Identification of different stages of Meiosis (permanent slides)

CORE COURSE T7: MOLECULAR BIOLOGY

Course Code: SH/MCB/ 303/C-7

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- This paper would enable students to have an overall knowledge about replication, transcription, post-transcriptional processing and translation of prokaryotes and eukaryotes.
- They will learn about regulation of gene expression.

Unit 1 Structures of DNA and RNA / Genetic Material	**No. of Hours: 12**
DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure and Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of Genome: Prokaryotes (*E. coli*), Eukaryotes (*S. cerevisiae*). 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, Θ (theta) mode of replication.	
Unit 3 Transcription in Prokaryotes and Eukaryotes	**No. of Hours: 8**
Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general transcription factors.	
Unit 4 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, its significance in brief.	
Unit 5 Translation (Prokaryotes and Eukaryotes)	**No. of Hours: 10**
Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Inhibitors of protein synthesis in prokaryotes and eukaryote.	
Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes	**No. of Hours: 12**
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms.	

Reference Books

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
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. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

CORE COURSE P7: MOLECULAR BIOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Study of different types of DNA and RNA using micrographs and model / schematic representations

2. Study of semi-conservative replication of DNA through micrographs / schematic representations

3. Estimation of purity of DNA & RNA sample through spectrophotometer.

4. Isolation of genomic DNA from *E. coli*

5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Semester - IV

CORE COURSE T8: MICROBIAL GENETICS

Course Code: SH/MCB/ 401/C-8

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will gain through knowledge on molecular aspects of cell, microbial genetics, and mechanisms of genetic exchange & transposable elements.

Unit 1 Genome Organization and Mutations	**No. of Hours: 18**
Genome organization of *E. coli* Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens;Molecular basis of mutations; Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes, Isolation, enrichment and selection of mutants. DNA repair Mechanism (mis-match, NER, SOS)	
Unit 2 Plasmids	**No. of Hours: 10**
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids. Isolation, purification & detection of plasmid DNA.	
Unit 3 Mechanisms of Genetic Exchange	**No. of Hours: 12**
Transformation - Discovery, mechanism, Identification of recombinants Conjugation - Discovery, mechanism, Hfr and F' strains Transduction - Generalized transduction, specialized transduction, Mapping by recombination and co-transduction of markers	
Unit 4 Transposable elements	**No. of Hours: 12**
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition Uses of transposons and transposition	

Reference Books

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, Benjamin Cummings

CORE COURSE P8: MICROBIAL GENETICS

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test through Audio-Visual Aids.

CORE COURSE T9: ENVIRONMENTAL MICROBIOLOGY

Course Code: SH/MCB/ 402/ C-9

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will study biogeochemical cycling & microbial interactions**.**
- Students will gain advanced knowledge on Waste Management treatment.

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.	
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 solubilization, Sulphur cycle: Microbes involved in Sulphur cycle, Other elemental cycles: Iron.	
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.	

Reference Books

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

Core Course P9: Environmental Microbiology

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
2. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
3. Assessment of microbiological quality of water.
4. Demonstration of BOD of waste water sample.
5. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase and protease) in soil.

CORE COURSE T10: FOOD AND DAIRY MICROBIOLOGY

Course Code: SH/MCB/ 403/C-10

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will study microbial spoilage of various foods, intrinsic and extrinsic factors of microbial activity.
- Students will gain knowledge on physical & chemical methods of food preservation.
- Students will have idea on beneficial role of gut probiotics, traditional fermented foods and their wide nutritional values.
- Students will study different food infections & intoxications.

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_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins	
Unit 4 Fermented foods	**No. of Hours: 10**
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, dahi and cheese, other fermented foods: dhosa, sauerkraut, soy sauce.	
Unit 5 Probiotics	**No. of Hours: 5**
General concept, salient features, and health benefits Mode of action of probiotics, Common probiotic foods	
Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures)	**No. of Hours: 10**
Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella typhi*, *Yersinia enterocolitica* and *Campylobacter jejuni*	
Unit 6 Food sanitation and control	**No. of Hours: 5**
HACCP, Indices of food sanitary quality and sanitizers	

Reference Books

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. CABInternational, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-HillPublishing 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. 7th edition, CBSPublishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality ofFoods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Core Course P10: Food and Dairy Microbiology

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. MBRT of milk samples and their standard plate count
2. Isolation of spoilage microorganisms from a rotten food sample
3. Preparation of Curd
4. Demonstration on Nutritional assessment of food product
5. A survey on fermented foods available in the local market
6. A visit to any food or beverage industry

Semester - V

CORE COURSE T11: INDUSTRIAL MICROBIOLOGY

Course Code: SH/MCB/501/C-11

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will achieve knowledge on Solid-state and liquid-state fermentation, Down-stream processing & other aspects of industrial microbiology
- Students will gain vivid knowledge on Enzyme immobilization and on microbial production of industrial products.
- A visit to an educational institute/industry will give students industry integrated education.

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: 10**
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: 12**
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: 18**
Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease) Wine, beer
Unit 6 Enzyme immobilization **No. of Hours: 4**
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase)

Reference Books

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

CORE COURSE P11: INDUSTRIAL MICROBIOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Isolation, preservation and maintenance of industrial strains
2. Study of different parts of fermenter
3. Demonstration of Microbial fermentations for the production and estimation (qualitative and quantitative) of:
   (a) Enzymes: Amylase and Protease
   (b) Alcohol: Ethanol
4. A visit to any Pharma/ Food/ Beverage industry.

CORE COURSE T12: IMMUNOLOGY

Course Code: SH/MCB/502/C-12

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will have fundamental concept on innate & adaptive immunity, immune cells and organs.
- Students will have concept on epitopes, adjuvants, haptens, MHC.
- Students will have knowledge on types, structure, and functions of antibodies.
- Students will gain knowledge on various types of Immunization, protocols of vaccine production.
- Students will perform advanced immunological Techniques.

Unit 1 Introduction	**No. of Hours: 10**
Fundamental concept of Innate and Adaptive immunity Generation of Humoral and Cell Mediated Immune Response Antibody dependent cellular cytotoxicity (ADCC) Contributions of following scientists to the development of field of immunology - Edward Jenner, Louis Pasteur, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet and Rodney Porter	
Unit 2 Immune Cells and Organs	**No. of Hours: 7**
Structure, functions and properties of Immune Cells –B cell, T cell, NK cell, Macrophage, Dendritic cell, Stem cell.Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen	
Unit 3 Antigens	**No. of Hours: 4**
Characteristics of an antigen; T-dependent and T-independent antigens Concept of Epitopes, Adjuvants, Haptens, Carrier	
Unit 4 Antibodies	**No. of Hours: 6**
Types , Structure, and Functions of antibodies Production and Clinical uses of Monoclonal antibodies	
Unit 5 Major Histocompatibility Complex	**No. of Hours: 5**
Organization of MHC locus (Mice & Human) Structure and Functions of MHC I & II molecules	
Unit 6 Complement System	**No. of Hours: 8**
Components of the Complement system Complement Activation pathways (Classical, Alternative and Lectin pathways) Biological consequences of complement Activation	
Unit 7 Autoimmunity	**No. of Hours: 4**
General concepts Organ-specific autoimmune diseases, Systematic autoimmune diseases	
Unit 8 Types of Immunization	**No. of Hours: 8**
Characteristics and functions of Active and Passive Immunization	

Unit 9 Immunological Techniques	No. of Hours: 8
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Immunoelectron microscopy	

Reference Books

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

CORE COURSE P12: IMMUNOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Separation of serum from the blood sample (demonstration)
2. Identification of human blood groups
3. Study of serum bactericidal activity
4. Demonstration of immunodiffusion by Ouchterlony method
5. Perform DOT ELISA technique
6. Determination of Lysozyme activity.

Semester - VI

CORE COURSE T13: MEDICAL MICROBIOLOGY

Course Code: SH/MCB/601/C-13

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- In medical microbiology students will gain through knowledge on various bacterial, viral, fungal & Protozoan diseases.
- Students will have knowledge on modes of action of Antibacterial, Antifungal and Antiviral agents.
- Students will carry out advanced diagnostic procedures.

Unit 1 Normal microflora of the human body and host pathogen interaction **No. of Hours: 8**
Normal microflora of skin, respiratory tract, gastrointestinal tract, urogenital tract Host pathogen interaction: Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers, reservoir, Opportunistic infections, Nosocomial infections, Epidemic, Endemic, Pandemic
Unit 2 Bacterial diseases **No. of Hours: 15**
Symptoms, mode of transmission, prophylaxis and control of following diseases: Respiratory Diseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis* Gastrointestinal Diseases: *Salmonella typhi*, *Vibrio cholerae* Others: *Bacillus anthracis, Treponema pallidum*
Unit 3 Viral diseases **No. of Hours: 14**
Salient features, mode of transmission, symptoms, prophylaxis and control of following diseases: Ebola, Dengue, Chikungunya, Japanese Encephalitis
Unit 4 Protozoan diseases **No. of Hours: 5**
Symptoms, mode of transmission, prophylaxis and control of following diseases: Malaria, Kala-azar
Unit 5 Fungal diseases **No. of Hours: 10**
Transmission, symptoms and prevention of following diseases: Cutaneous mycoses: Tinea pedis (Athlete's foot)

Systemic mycoses: Histoplasmosis

Opportunistic mycoses: Candidiasis

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

Source, Chemical structure and mode of action of Antibiotics.

Modes of action Antifungal and Antiviral agents with example.

Reference Books

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. 4thedition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical Microbiology. 3rd edition, Mosby, Inc

CORE COURSE P12: IMMUNOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, TCBS
2. Study of bacterial flora of skin from different skin abscesses by swab method
3. Collection of clinical samples (Sputum, Skin, Blood, Urine and Stool)
4. Perform antibacterial sensitivity by Agar cup/ disc diffusion method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/ Streptomycin)
6. Determination of extracellular enzyme-producing ability of bacteria

CORE COURSE T14: RECOMBINANT DNA TECHNOLOGY

Course Code: SH/MCB/602/C-14

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will learn about tools and strategies of Molecular Cloning.
- Students will learn about DNA amplification, sequencing and construction cDNA libraries.
- Students will be acquainted with applied field of Recombinant DNA Technology.

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**
Mode of action and applications of Type I, II and III restriction endonuclease in genetic engineering; Definition and function of restriction site, linkers, adaptors, Topoisomerase, DNA ligase, Genomic library. DNA Modifying enzymes: Terminal deoxy nucleotidyl transferase, kinases, phosphatase Definition and Properties of following Cloning Vectors: pBR322, pUC8, pUC pair, Bacteriophage lambda, M13, Cosmids, BACs and YACs vectors Mammalian SV40-based expression vectors	
Unit 3 Methods in Molecular Cloning	**No. of Hours: 16**
Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome andviral mediated delivery, *Agrobacterium* - mediated delivery Agarose gel electrophoresis, Southern and Northern blotting, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting	
Unit4 DNA Amplification and DNA sequencing	**No. of Hours: 10**
Basic concept 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 and 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: Insulin, hGH, Antisense molecules Bt transgenic - cotton, brinjal Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis	

Reference Books

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education

CORE COURSE P14: RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

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

DISCIPLINE SPECIFIC ELECTIVES

Semester - V

DSE-1 T: INSTRUMENTATION AND BIOTECHNIQUES

Course Code: SH/MCB/503/DSE-1

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will be acquainted with ultra-modern sophisticated instruments and Biotechniques.

Unit 1 Advanced Microscopy	**No. of Hours: 12**
Working Principle & application of Scanning Electron Microscope, Transmission Electron Microscope, Confocal & fluorescence microscope	
Unit 2 Chromatography	**No. of Hours: 12**
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: 12**
Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, and Agarose gel electrophoresis.	
Unit 4 Spectrophotometry	**No. of Hours: 12**
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, principle and application of differential centrifugation, density gradient centrifugation and ultracentrifugation.	

Reference Books

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and MolecularBiology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. JohnWiley & 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. 5th 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.

DSE-1 P: INSTRUMENTATION AND BIOTECHNIQUES

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Ray diagrams of phase contrast microscopy
2. Separation of mixtures by paper / thin layer chromatography
3. Study of bacterial colony by stereo microscope
4. Test of cell surface hydrophobicity through Spectrophotometry
5. Separation of components of a given mixture using centrifuge
6. Industrial Tour/ Institute visit

DSE-1 T: INHERITANCE BIOLOGY

Course Code: SH/MCB/503/DSE-1

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- This paper would enable students to have an overall knowledge about replication, transcription, post-transcriptional processing and translation of prokaryotes and eukaryotes.
- They will learn about regulation of gene expression.

Unit 1 Introduction to Genetics **No. of Hours: 5**

Historical developments

Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis elegans 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: 9**

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

Unit 4 Extra-Chromosomal Inheritance **No. of Hours: 9**

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaea peregra* Infectious heredity - Kappa particles in *Paramecium*

Unit 5 Characteristics of Chromosomes	**No. of Hours: 15**
Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome	
Unit 6 Recombination	**No. of Hours: 3**
Homologous and non-homologous recombination, including transposition, site-specific recombination.	
Unit 7 Human genetics	**No. of Hours: 3**
Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.	
Unit 8 Quantitative genetics	**No. of Hours: 3**
Polygenic inheritance, heritability and its measurements, QTL mapping.	

Reference Books

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. 9th 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

DSE-1 P: INHERITANCE BIOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying *Rhoeo* translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

DSE-2 P: DISSERTATION WORK

Course Code: SH/MCB/504/DSE-2

(Credits 6/ Lectures 120 /Marks 50)

Learning Outcome

- Students will be benefitted by the literature review, research & analysis. It will further widen their knowledge for higher research.

Dissertation Work

This paper would focus on the **project work / Dissertation** to be carried out by the students under the supervision of the teacher(s) in the college/ Research Institute.

The topic of the project would be selected by each group of students in consultation with the supervisor. The Dissertation of the student must include: **Objectives, Review of Literature, Methodology, Result and Discussion, Conclusion**.

The grading would be based on continuous evaluation that would include punctuality, hard work,record keeping, research analysis, intellectual inputs, data presentation, interpretation etc.

Finally, the student has to give power-point presentation at the time of submission of the Dissertation.

Semester - VI

DSE-3T: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

Course Code: SH/MCB/603/DSE-3

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will learn about microbes for sustainable development of agriculture.
- Students will have knowledge on biofertilization, phytostimulation, bioinsecticides, biomanure, biogas, biofuels and on GM crops.

Unit 1 Soil Microbiology	**No of Hours: 8**
Soil as Microbial Habitat Diversity and distribution of microorganisms in soil	
Unit 2 Mineralization of Organic & Inorganic Matter in Soil	**No of Hours: 8**
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium	
Unit 3 Microbial Activity in Soil and Green House Gases	**No of Hours: 5**
Carbon dioxide, methane – production and control	
Unit 4 Microbial Control of Soil Borne Plant Pathogens	**No of Hours: 8**
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial Plant pathogens, Insects, Weeds	
Unit 5 Biofertilization, Phytostimulation, Bioinsecticides	**No of Hours: 15**
General concept of Biofertilizers – Phosphate solubilizing Microorganism Nitrogen fixing Microorganism (Symbiotic and Non Symbiotic)	
Unit 6 Secondary Agriculture Biotechnology	**No of Hours: 10**
Biomanure, biogas, biofuels – Principle, advantages and processing parameters	
Unit 7 GM crops	**No of Hours: 6**
Advantages, social and environmental aspects of Bt crops, golden rice, transgenic animals	

Reference Books

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 4th edition, ASMPress,
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

DSE-3 P: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Study microflora of different types of soils
2. Isolation and characteristics of *Rhizobium* from leguminous plant
3. A visit to biogas plant
4. Isolation of cellulose degrading microorganisms
5. Isolation of phosphate solubilizing microorganisms

DSE-3T: PLANT PATHOLOGY

Course Code: SH/MCB/603/DSE-3

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students can have the knowledge about various plant diseases
- They will also be informed about contributors of the subject.

Unit 1 Introduction and History of plant pathology	**No. of Hours: 5**
Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.	
Unit 2 Stages in development of a disease	**No. of Hours: 2**
Infection, invasion, colonization, dissemination of pathogens and perennation.	
Unit 3 Plant disease epidemiology	**No. of Hours: 5**
Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.	
Unit 4 Host Pathogen Interaction	**No. of Hours: 19**
A. *Microbial Pathogenicity* Virulence factors of pathogens: enzymes, toxins (host specific and non-specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). B. *Genetics of Plant Diseases* Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. C. *Defense Mechanisms in Plants* Concepts of constitutive defense mechanisms in plants.	
Unit 5 Control of Plant Diseases	**No. of Hours: 10**
Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants	

genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit 6 Specific Plant diseases **No. of Hours: 19**

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control

A. Important diseases caused by fungi

Downy mildew of onion - *Peronospora destructor*

Late blight of potato - *Phytophthora infestans*

B. Important diseases caused by phytopathogenic bacteria:

crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn

D. Important diseases caused by viruses: Papaya ring spot, banana bunchy Top disease

E. Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadang

Reference Books

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

DSE-3P: PLANT PATHOLOGY

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

DSE-4T: BIOINFORMATICS

Course Code: SH/MCB/604/DSE-4

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will be highly benefitted by using different software & tools for analysis of biological data

Unit 1 Introduction to Computer Fundamentals	**No. of Hours: 8**
RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer	
Unit 2 Introduction to Bioinformatics and Biological Databases	**No. of Hours: 14**
Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB	
Unit 3 Sequence Alignments, Phylogeny and Phylogenetic trees	**No. of Hours: 16**
Local and Global Sequence alignment, pairwise and multiple sequence alignment.Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood	
Unit 4 Genome organization and analysis	**No. of Hours: 10**
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes Genome, transcriptome, proteome, 2-D gel electrophoresis, MaldiToff spectroscopyMajor features of completed genomes: *E.coli, S.cerevisiae, Arabidopsis,* Human	
Unit 5 Protein Structure Predictions	**No. of Hours: 12**
Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure templateEnergy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design	

Reference Books

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International StudentEdition

4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications,genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

DSE-4 P: BIOINFORMATICS

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI, EMBL, DDBJ, Swiss-prot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using varous online based tools clustal W & phylip
5. Retrieval of Genomic/Gene Data from different Databases/tools JGI-IMG or GENSCAN,
6. Protein structure prediction: primary structure analysis, secondary structure prediction using

Molecular visualization of proteins using Jmol or PyMol

DSE-4T: BIOMATHEMATICS AND BIOSTATISTICS

Course Code: SH/MCB/604/DSE-4

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will be highly benefitted by using different software & tools for analysis of biological data

Unit 1 Biomathematics **No of Hours: 30**

Sets. Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc.

Simple observations about these functions like increasing, decreasing and, periodicity.

Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence.

Infinite Geometric Series. Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions.

Integration as reverse process of differentiation.

Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations.

Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

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;

Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;

Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics;

Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom;

Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test;

Basic introduction to Multivariate statistics, etc.

Reference Books

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.

DSE-4 P: BIOMATHEMATICS AND BIOSTATISTICS

TOTAL HOURS: 60 **Marks: 15 Credits: 2**

List of Practical

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

SKILL ENHANCEMENT COURSES

Semester - III

SEC-1P: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

Course Code: SH/MCB/ 305/SEC-1

TOTAL HOURS: 30 **Marks: 40 Credits: 2**

Learning Outcome

- Students will gain knowledge and hands-on-training regarding diagnostic procedures in health clinics.

PRACTICAL
Unit 1:
Collection of clinical samples (Sputum, Skin, Blood, Urine and Stool) with proper precautions
Unit 2:
Method of transport and storage of clinical samples
Unit 3:
Examination of sample by staining - Gram staining, Ziehl-Neelson staining
Unit 4:
Preparation and use of culture media - Blood agar, Chocolate agar, TCBS Agar, MacConkey agar
Unit 5:
Rapid Detection of Typhoid
Unit 6:
Determination of resistance/sensitivity of bacteria against antibiotic (Penicillin/Streptomycin) using disc diffusion method
Unit 7:
Determination of minimal inhibitory concentration (MIC) of an antibiotic (Penicillin/ Streptomycin)

Reference Books

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
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. Collee JG, Duguid JP, Fraser AG, Marmion BP(1989) Practical Medical Microbiology, 13th edition, Churchill Livingstone
4. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology

SEC-1P: MANAGEMENT OF HUMAN MICROBIAL DISEASES

Course Code: SH/MCB/ 305/SEC-1

TOTAL HOURS: 30 **Marks: 40 Credits: 2**

Learning Outcome

- Students will gain knowledge and hands-on-training regarding diagnostic procedures in health clinics.

PRACTICAL
Unit 1
Study of Respiratory microbial diseases
Unit 2
Study of gastrointestinal microbial diseases
Unit 3
Study of skin, eye and urinary tract diseases
Unit 4
Study of Sexually transmitted diseases
Unit 5
Study of DOTS therapy
Unit 6
Study of HAART therapy
Unit 7
A visit to Pharma Industry
Reference Books
1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication 2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication 3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier 4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education 5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Semester - IV

SEC-2P: FOOD FERMENTATION TECHNIQUES

Course Code: SH/MCB/ 405/SEC-2

TOTAL HOURS: 30 **Marks: 40 Credits: 2**

Learning Outcome

- Students will study fermenting organisms from different foods
- Students will gain knowledge and hands-on-training on preparation of fermented foods

PRACTICAL
Unit 1:
Isolation and characterization of microorganisms from a fermented food
Unit 2:
Preparation of Milk-based fermented foods (Buttermilk, Dahi vada)
Unit 3:
Preparation of Grain-based fermented foods (Bread, Idli, Dosa)
Unit 4:
Preparation of vegetable-based fermented foods (Pickels, Saeurkraut)
Unit 5:
Isolation and characterization of microorganisms from a rotten food

Reference Books

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

SEC-2P: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

Course Code: SH/MCB/ 405/SEC-2

TOTAL HOURS: 30 **Marks: 40 Credits: 2**

Learning Outcome

- Students can have the knowledge and hands-on-training about microbiological analysis of air and water.

PRACTICAL
Unit 1:
Bioaerosol sampling, growth on culture media and CFU counting
Unit 2:
Standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests of water potability
Unit 3:
Isolation and morphological characterization of bacteria from aquatic water
Unit 4:
Analysis of water sample by Membrane filter technique
Unit 5:
Demonstration on the function of UV light, HEPA filters, desiccation, Incineration, Precipitation, chemical disinfection and filtration

Reference Books

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press

2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

GENERAL ELECTIVE COURSES

Semester - I

GE-1 T: INTRODUCTION AND SCOPE OF MICROBIOLOGY

Course Code: SH/MCB/ 103/GE-1

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students learn about history & development of microbiology.
- Students acquired a fairly good understanding of the Diversity of the microbes.
- Students get good understanding of the Microscope & other important instruments in laboratory.
- Students gather practical skills of handing microorganisms in the laboratory for study.

Unit 1 History and Development of Microbiology	**No. of Hours: 12**
History and Development of microbiology Theory of Spontaneous generation, Germ theory of disease Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner.	
Unit 2 Diversity of Microorganisms	**No. of Hours: 14**
Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa)	
Unit 3 Principle and Application of Important Instruments	**No. of Hours: 6**
Biological Safety Cabinet, Autoclave, Incubator, Hot Air Oven, Light Microscope.	
Unit 4 Media Type	**No. of Hours: 8**
A brief idea regarding Media type (Natural, Synthetic, Semi-synthetic, Selective and Differential) and Preservation of Microorganisms.	
Unit 5 Microscopy	**No. of Hours: 8**
Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Transmission Electron Microscope, Scanning Electron Microscope	
Unit 6 Microbes in Human Health & Environment	**No. of Hours: 12**
List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types Definitions and examples of important microbial interactions –mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizer, biodegradation,	

GE-1P: INTRODUCTION AND SCOPE OF MICROBIOLOGY

(Practical: Credits 2/ Lectures 60 Marks: 15)

List of Practical

1. Microbiology Laboratory Management and Biosafety
2. To study the principle and applications of important instruments (autoclave, incubator, hot air oven, centrifuger, light microscope, pH meter) used in themicrobiology laboratory
3. Preparation of Natural mediafor bacterial cultivation
4. Preparation of Culture media (Nutrient Broth an Nutrient Agar) for bacterial cultivation
5. Preparation of Semi-synthetic media (PDF).
6. Sterilization of medium using Autoclave and assessment for sterility
7. Sterilization of glassware using Hot Air Oven

Reference Books

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

Semester - II

GE-2 T: BACTERIOLOGY AND VIROLOGY

Course Code: SH/MCB/ 203/GE-2

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students acquired a fairly good understanding of the different types of bacteria and viruses.
- Students get good understanding of the different isolation technique of bacteria & virus.
- Students gather practical skills of handing bacteria & viruses in the laboratory for study.

Unit 1 Cell Organization	**No. of Hours: 10**
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, Gram staining mechanisms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial cell membranes. Cytoplasm: Ribosomes, mesosomes, nucleoid and plasmids Endospore: Structure, formation, stages of sporulation.	
Unit 2 Bacteriological Techniques	**No. of Hours: 8**
Pure culture isolation: Serial dilution, Streaking, Spreading and pour plating methods; Preservation of pure cultures by Slant and Stab methods.	
Unit 3 Bacterial growth & Control	**No. of Hours: 10**
Growth: Binary fission, phases of growth , Diauxic growth , Physical methods of microbial control: heat, filtration, radiation Chemical methods of microbial	
Unit 4 Introduction to Viruses	**No. of Hours: 8**
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: 12**
Viruses as pathogens: Role of viruses in causing diseases Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds	

GE-2 P: BACTERIOLOGY AND VIROLOGY

(Practical: Credits 2/ Lectures 60 Marks: 15)

List of Practical
1. Simple staining 2. Gram's staining 3. Endospore staining. 4. Isolation of pure cultures of bacteria by streaking method. 5. Preservation of bacterial cultures (slant / stab). 6. Estimation of CFU count by spread plate method/pour plate method. 10. Demonstration of Plaque assay
Reference Books
1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers. 2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall 3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc. 4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill. 5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht 6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan. 7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education. 8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. 9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

Semester - III

GE-3 T: MICROBIAL METABOLISM

Course Code: SH/MCB/ 304/GE-3

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students gather good understandings about microbial growth, their nutrition.
- Students will be acquainted with different metabolism and their energy generation.
- Students can have brief idea about Passive and facilitated diffusion & Nutrient uptake procedure.
- Students will analysis effect of temperature, pH & NaCl on bacterial growth.

Unit 1 Microbial Growth	**No. of Hours: 12**
Definitions of growth, measurement of microbial growth, Generation time, Kinetics of Growth, Batch culture, Phases of Growth, Continues culture, Chemostat, Turbidostat.Synchronous growth, Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe).	
Unit 2 Microbial Nutrition	**No. of Hours: 12**
Define Nutrition, Nutritional types (Definition with example only) – Autotroph/Phototroph, heterotroph, Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrate, Sulphur, Hydrogen, Iron oxidizing bacteria), Chemoorganotrophs.	
Unit 3 Nutrient uptake and Transport	**No. of Hours: 8**
Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake	
Unit 4 Aerobic Respiration	**No. of Hours: 12**
Concept of aerobic respiration. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway. TCA cycle. Brief concept of Electron transport chain: components of respiratory chain.	
Unit 4 Anaerobic Respiration	**No. of Hours: 12**
Brief description regarding Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction. Fermentation - Alcohol fermentation; Lactate fermentation (homofermentative and heterofermentative Pathways).	

GE-3 P: MICROBIAL METABOLISM

(Practical: Credits 2/ Lectures 60 Marks: 15)

List of Practical

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of salt on growth of *E. coli*

Reference Books

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

Semester - IV

GE-4 T: MEDICAL MICROBIOLOGY AND IMMUNOLOGY

Course Code: SH/MCB/ 404/GE-4

(Theory: Credits 4/ Lectures 60 /Marks 25)

Learning Outcome

- Students will have fundamental concept on innate & adaptive immunity, immune cells and organs.
- Students will have concept on different microbial diseases.
- Students will have knowledge on types, structure, and functions of antibodies.
- Students will gain knowledge on various types of Immunological techniques

Unit 1 Normal microflora of the human body and host pathogen interaction	**No. of Hours: 12**
Normal microflora of skin, respiratory tract, gastrointestinal tract, urogenital tract Host pathogen interaction: Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers, reservoir, Opportunistic infections, Nosocomial infections, Epidemic, Endemic, Pandemic	
Unit 2Microbial diseases	**No. of Hours: 12**
Transmission, pathogenicity, prevention and treatment of following diseases: **Bacterial**: Typhoid **Viral:** AIDS **Fungal:** Candidiasis	
Unit 3 Immune Cells and Organs	**No. of Hours: 12**
Structure, Functions and Properties of: Immune Cells –B cell, T cell, NK cell, Macrophage, Dendritic cell, Stem cell Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen	
Unit 4 Antigens and Antibodies	**No. of Hours: 10**
Characteristics of an antigen, Concept of Epitopes, Adjuvants, Haptens, Carrier Types , Structure and Functions of antibodies.	
Unit 5 Generation of Immune Response	**No. of Hours: 8**
Generation of Humoral and Cell Mediated Immune Response Antibody dependent cellular cytotoxicity (ADCC)	
Unit 6 Immunological Techniques	**No. of Hours: 6**
Principles of Precipitation, Agglutination, Immunoelectrophoresis, ELISA, ELISPOT	

GE-4 P: MEDICAL MICROBIOLOGY AND IMMUNOLOGY

(Practical: Credits 2/ Lectures 60 Marks: 15)

List of Practical

1. Identify bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC, nitrate reduction, acid & gas production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar/ McConkey agar, Mannitol salt agar.
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Identification of human blood groups
6. To separate serum from the blood sample (demonstration).

Reference Books

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

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