CHOICE BASED CREDIT SYSTEM

Scheme of Instruction & Syllabus for

B.Sc. MICROBIOLOGY

2021-2022

JIS UNIVERSITY

B.Sc. (Hons.) Microbiology

Department of Biotechnology

Revised Curriculum Structure to be effective from

2021-2022

Credit Distribution across the Course				
Course Type	**Total Papers**	**Credit**		**Total Credit**
		Theory	**Practical**	
CC	14	14 X 4=56	14 X 2 = 28	56+28 = **84**
DSE	4	4 X 4=16	14 X 2 = 28	16+08 = **24**
GE	4	4 X 4=16	4 X 2 = 08	16+08 = **24**
SEC	2	2x2=4		**04**
AECC	4	4x2=8		**08**
Total				**144**

Abbreviations used:
CC = CORE COURSES
DSE = DISCIPLINE SPECIFIC ELECTIVES
GE = GENERAL ELECTIVES
SEC = SKILL ENHANCEMENT COURSES
AECC = ABILITY ENHANCEMENT COMPULSORY COURSES

List of Core Courses (14 Papers for the Students of Biotechnology)		**Semester**
CORE I	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY	**I**
CORE II	BIOCHEMISTRY	
CORE III	MICROBIAL PHYSIOLOGY AND METABOLISM	**II**
CORE IV	BACTERIOLOGY	
CORE V	MICROBIAL GENETICS	**III**

CORE VI	MOLECULAR BIOLOGY	
CORE VII	ENVIRONMENTAL MICROBIOLOGY	
CORE VIII	IMMUNOLOGY	**IV**
CORE IX	BIOINFORMATICS	
CORE X	MEDICAL MICROBIOLOGY	
CORE XI	INDUSTRIAL MICROBIOLOGY	**V**
CORE XII	RECOMBINANT DNA TECHNOLOGY	
CORE XIII	FOOD AND DAIRY MICROBIOLOGY	**VI**
CORE XIV	BIOSTATISTICS	

Choices for DSE

(2 Papers each to be selected by the Students of Biotechnology SemV and SemVI)

	SUBJECT NAME	**CODE**
DSE_1	MICROBIAL BIOTECHNOLOGY	XMI5003
DSE_2	ADVANCES IN MICROBIOLOGY	XMI5004
DSE _3	INHERITANCE BIOLOGY	XMI5005
DSE_4	MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT	XMI6003
DSE_5	PLANT PATHOLOGY	XMI6004
DSE_6	BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS	XMI6005
DSE_7	REVIEW WRITING	XMI6106

Choices for SEC

(Any one per semester in semesters 3-4)

	SUBJECT NAME	**CODE**
SEC_1	MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES	XMI3004

SEC_2	MICROBIAL DIAGNOSIS IN HEALTH CLINICS	XMI3005
SEC_3	BIOFERTILIZERS AND BIOPESTICIDES	XMI3006
SEC_4	FOOD FERMENTATION TECHNIQUES	XMI4004
SEC_5	MANAGEMENT OF HUMAN MICROBIAL DISEASES	XMI4005
SEC_6	MICROBIOLOGICAL ANALYSIS OF AIR AND WATER	XMI4006

Choices for AECC (Any one per semester in semesters 3-4)		
	SUBJECT NAME	**CODE**
AECC_1	ENGLISH	XED1001
AECC_2	ENVIRONMENTAL SCIENCE	XBT2003
AECC_3	ENTREPRENEURSHIP DEVELOPMENT	XBB3009
AECC_4	VALUES AND ETHICS	

SEMESTER-1							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI1001	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY	3	1	0	4
2	CORE	XMI1002	BIOCHEMISTRY	3	1	0	4
3	GE I		GENERAL ELECTIVE I	3	1	0	4
4	AECC I	XED1001	ENGLISH	2	0	0	2
PRACTICAL							
5	CORE	XMI1101	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY LAB	0	0	3	2
6	CORE	XMI1102	BIOCHEMISTRY LAB	0	0	3	2
7	GE I		GENERAL ELECTIVE I LAB	0	0	3	2
TOTAL				**11**	**3**	**9**	**20**

SEMESTER-2							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI2001	MICROBIAL PHYSIOLOGY AND METABOLISM	3	1	0	4
2	CORE	XMI2002	BACTERIOLOGY	3	1	0	4
3	GE II		GENERAL ELECTIVE II	3	1	0	4
4	AECC II	XBT2003	ENVIRONMENTAL SCIENCE	2	0	0	2
PRACTICAL							
5	CORE	XMI2101	MICROBIAL PHYSIOLOGY AND METABOLISM LAB	0	0	3	2
6	CORE	XMI2102	BACTERIOLOGY LAB	0	0	3	2
7	GE II		GENERAL ELECTIVE II LAB	0	0	3	2
TOTAL				**11**	**3**	**9**	**20**

SEMESTER-3							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI3001	MICROBIAL GENETICS	3	1	0	4
2	CORE	XMI3002	MOLECULAR BIOLOGY	3	1	0	4
3	CORE	XMI3003	ENVIRONMENTAL MICROBIOLOGY	3	1	0	4
4	GE III		GENERAL ELECTIVE III	3	1	0	4
5	SEC I		SKILL ENHANCE COURCES I	2	0	0	2
6	AECC III	XBB3009	ENTREPRENEURSHIP DEVELOPMENT	2	0	0	2
PRACTICAL							
7	CORE	XMI3101	MICROBIAL GENETICS LAB	0	0	3	2
8	CORE	XMI3102	MOLECULAR BIOLOGY LAB	0	0	3	2
9	CORE	XMI3103	ENVIRONMENTAL MICROBIOLOGY LAB	0	0	3	2
10	GE III		GENERAL ELECTIVE III LAB	0	0	3	2
TOTAL				**16**	**4**	**12**	**28**

SEMESTER-4							
Sl. No	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI4001	BIOINFORMATICS	3	1	0	4
2	CORE	XMI4002	IMMUNOLOGY	3	1	0	4
3	CORE	XMI4003	MEDICAL MICROBIOLOGY	3	1	0	4
4	GE IV		GENERAL ELECTIVE IV	3	1	0	4
5	SEC II		SKILL ENHANCE COURCES II	2	0	0	2
6	AECC IV		VALUES AND ETHICS	2	0	0	2
PRACTICAL							
7	CORE	XMI4101	BIOINFORMATICS LAB	0	0	3	2
8	CORE	XMI4102	IMMUNOLOGY LAB	0	0	3	2
9	CORE	XMI4103	MEDICAL MICROBIOLOGY LAB	0	0	3	2
10	GE IV		GENERAL ELECTIVE IV LAB	0	0	3	2
TOTAL				**16**	**4**	**12**	**28**

SEMESTER-5							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI5001	INDUSTRIAL MICROBIOLOGY	3	1	0	4
2	CORE	XMI5002	RECOMBINANT DNA TECHNOLOGY	3	1	0	4
3	DSE I		DISCIPLINE CENTRIC SUBJECTS I	3	1	0	4
4	DSE II		DISCIPLINE CENTRIC SUBJECTS II	3	1	0	4
PRACTICAL							
5	CORE	XMI5101	INDUSTRIAL MICROBIOLOGY LAB	0	0	3	2
6	CORE	XMI5102	RECOMBINANT DNA TECHNOLOGY LAB	0	0	3	2
7	DSE I		DISCIPLINE CENTRIC SUBJECTS I LAB	0	0	3	2
8	DSE II		DISCIPLINE CENTRIC SUBJECTS II LAB	0	0	3	2
TOTAL				**12**	**4**	**12**	**24**

SEMESTER-6							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI6001	FOOD AND DAIRY MICROBIOLOGY	3	1	0	4
2	CORE	XMI6002	BIOSTATISTICS	3	1	0	4
3	DSE I		DISCIPLINE CENTRIC SUBJECTS III	3	1	0	4
4	DSE II		DISCIPLINE CENTRIC SUBJECTS IV	3	1	0	4
PRACTICAL							
5	CORE	XMI6101	FOOD AND DAIRY MICROBIOLOGY LAB	0	0	3	2
6	CORE	XMI6102	BIOSTATISTICS LAB	0	0	3	2
7	DSE I		DISCIPLINE CENTRIC SUBJECTS III LAB	0	0	3	2
8	DSE II		DISCIPLINE CENTRIC SUBJECTS IV LAB	0	0	3	2
TOTAL				**12**	**4**	**12**	**24**

Detail Syllabus B.Sc. Microbiology Semester-1

SEMESTER-1							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI1001	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY	3	1	0	4
2	CORE	XMI1002	BIOCHEMISTRY	3	1	0	4
3	GE I		GENERAL ELECTIVE I	3	1	0	4
4	AECC I	XED1001	ENGLISH	2	0	0	2
PRACTICAL							
5	CORE	XMI1101	INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY LAB	0	0	3	2
6	CORE	XMI1102	BIOCHEMISTRY LAB	0	0	3	2
7	GE I		GENERAL ELECTIVE I LAB	0	0	3	2
TOTAL				**11**	**3**	**9**	**20**

Course Code	XMI1001			
Course Title	Introduction To Microbiology And Microbial Diversity			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: To become familiar with the foundation concepts of Microbiology

CO2: To understand history, relevance of microbiology and classification of microscopic organisms

CO3: Give a complete understanding about the structure and functions of a typical prokaryotic and eukaryotic microscopic cells

CO4: Students will be acquainted with how Microbiology developed and what is the scope of the various branches of the subject.

Course Content:

Module 1: History of Development of Microbiology [20L]

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

Module 2: Diversity of Microbial World [20L]

Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms; General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of

reproduction and economic importance.

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

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

Protozoa: General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and GiardiaOverview – problem definition, logical reasoning. Flowcharts – symbols used, examples.

Module 3: An overview of Scope of Microbiology [8L]

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI1101			
Course Title	Introduction To Microbiology And Microbial Diversity Practicals			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	2	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.

Course Outcome:

CO1: Acquiescence to recognize the microscopic characteristics of microorganisms

CO2: Ability to utilize microbiological concepts to summarize, analyses, and synthesize scientific and microbiology-related literature.

CO3: Demonstrability of practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments with appropriate controls.

CO4: Students will be acquainted with how Microbiology developed and what is the scope of the various branches of the subject.

Suggestive List of Experiments:

1. Preparation of culture media for bacterial cultivation.

[2 days]

2. Sterilization of medium using Autoclave and assessment for sterility

[1 day]

3. Sterilization of glassware using Hot Air Oven and assessment for sterility

[2 days]

4. Sterilization of heat sensitive material by membrane filtration and assessment for sterility

[1 day]

5. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

[2 day]

6. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts.

[1 day]

7. Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts

[1 day]

8. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium.

[2 days]

Text / Reference Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
2. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General
3. Microbiology. 5th edition. McMillan.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	1	2	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	2	1	-	-	-	-	-	-

Course Code	XMI1002			
Course Title	Biochemistry			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course Outcome:

CO1: Inculcate an understanding of the function of biological molecules through the study of their molecular structure, and interaction with other biomolecules.

CO2: Develop a documented understanding of the chemical and regulatory interrelationship between major cellular synthetic and catabolic pathways by participating in class discussions, and completing quizzes and exams.

CO3: Demonstrate an awareness of the impact of biochemistry on the environment, society, and other cultures outside the scientific community.

CO4: Inquisitiveness to find application of biochemistry in medical and biological field settings.

Course Content:

Module 1: Bioenergetics: [10L]

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP.

Module 2: Carbohydrates: [10L]

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

polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

Module 3: Lipids: **[10L]**

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

Module 4: Proteins: **[10L]**

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

Module 5: Enzymes: **[6L]**

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

Modules 6: Vitamins: **[2L]**

Classification and characteristics with suitable examples, sources and importance

Text / Reference Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman

4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI1102			
Course Title	Biochemistry Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course Outcome:

CO1: Ability to draw on classroom knowledge and laboratory classes to make an individual contribution in a research laboratory.

CO2: Ability to draw on classroom knowledge and laboratory classes to make an individual contribution in a research laboratory

CO3: Correlate the theoretical basis of the tools, technologies and methods common to Biochemistry.

Suggestive List of Experiments:

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts.

[2 days]

2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant

[1 day]

3. Standard Free Energy Change of coupled reactions

[2 days]

4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars

[2 days]

5. Qualitative/Quantitative tests for lipids and proteins

[2 days]

6. Study of protein secondary and tertiary structures with the help of models

[1 day]

7. Study of enzyme kinetics – calculation of V_{max}, Km, Kcat values

[1 day]

8. Study effect of temperature, pH and Heavy metals on enzyme activity

[1 day]

9. Estimation of any one vitamin

[1 day]

Text / Reference Books:

1. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
2. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	1	2	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	2	1	-	-	-	-	-	-

Course Code	XCA1003			
Course Title	Computer Fundamentals			
Category	GE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	Basic idea of Computer			

Learning objectives:

To understand characteristics of computers, basic computer organization.

To know number system, binary arithmetic, Boolean Algebra & Logic Circuit.

Idea about storages and input output devices, computer software, computer languages, Algorithm, Flowcharts.

To write different application like MS Paint, Office.

To understand about Operating System, Data Communication & Networks and Internet.

Course Outcome:

CO1: Understanding characteristics of computers, basic computer organization.

CO2: Knowledge of number system, binary arithmetic, Boolean Algebra & Logic Circuit.

CO3: Idea about storages and input output devices, computer hardware, software, computer languages, Algorithm, Flowcharts.

CO4: Write different application like MS Paint, MS Office (MS Word, MS Excel, MS PowerPoint and MS Access).

CO5: Understanding about Operating System, Data Communication & Networks and Internet.

Course Content:

Module 1: Introduction of computer and Basic computer organization (3L)

Introduction of computer: Characteristics of Computer, Evolution of Computer, Generations of Computer (I, II, III, IV, V), Classifications of Computer (2L)

Basic computer organization : Input Unit, Output Unit, Storage Unit, Arithmetic & Logic Unit, Control Unit, Central Processing Unit, The system concepts (1L)

Module 2: Number System, Binary Arithmetic, Codes & Logic Gates (9L)

Number System: Digit Concept, Bit, Byte, Nibble, Word, Weights, Base and Fractions, Decimal Number System, Binary Number System, Octal Number System, Hexadecimal Number System (1L)

Conversion (Number & Fraction): Decimal to Binary, Decimal to Octal, Decimal to Hexadecimal, Binary to Decimal, Binary to Octal, Binary to Hexadecimal, Octal to Decimal, Octal to Binary, Octal to Hexadecimal, Hexadecimal to Decimal, Hexadecimal to Binary, Hexadecimal to Octal (4L)

Binary Arithmetic: Binary Addition, Binary Subtraction, Binary Multiplication, Binary Division, Concepts of 1's complement and 2's complement, Binary Subtraction using 1's complement and 2's complement (2L)

Computer Codes: Weighted code (BCD, EBCDIC, ASCII, 8421, 2421, 84-2-1, Excess-3), Non-weighted code (Gray Code), Conversion from Binary to Gray code, Conversion from Decimal to BCD, Conversion BCD to Decimal (1L)

Logic Gate: Rules, symbol, truth table and circuit diagrams of NOT, OR, AND, NOR, NAND, XOR, EX-NOR, BUFFER and Negative-OR, Universal Gate, NOT, OR & AND using Universal Gates (1L)

Module 3: Storage and Input/output Devices, Computer Hardware & Software, Computer Language, Program Planning and Language Processor (8L)

Primary Storage: RAM (SRAM, DRAM), ROM (MROM, PROM, EPROM, EEPROM), Cache Memory, Register, Motherboard and Memory unit (1L)

Secondary Storage: Sequential & Direct Access devices, Punched Paper Tape, Magnetic Tape, Tape Cassettes & Cartridges, Magnetic Disk, Floppy Disk, Winchester Disk, Magnetic Drum, Magnetic Bubble Memory, Optical Disk, Flush Drives (2L)

Input Devices: Keyboard, Mouse, Joy Stick, Light pen, Track Ball, Scanner, Graphic Tablet, Microphone, Magnetic Ink Card Reader (MICR), Optical Character Reader (OCR), Bar Code Reader (BCR), Optical Mark Reader (OMR) (1L)

Output Devices: Monitor (Cathode-Ray Tube (CRT), Flat Panel Display (LCD, LED, Plasma, 3D)), Printer (Impact (Character (Dot-matrix, Daisy Wheel), Line (Drum, Chain)), Non-impact (Laser, Inkjet)), Plotter (Drum, Flatbed) (1L)

Computer Hardware & Software: Port, Hardware, Relation between hardware and software, Software (System Software and Application Software) (1L)

Programming Planning: Purpose, Algorithm, Flowcharts, Decision Tables, Pseudo code (1L)

Computer Language & Language Processor: Low level (Machine level, Assembly level), High level (Procedure-oriented, Object-oriented), Assembler, Compiler & Interpreter (1L)

Module 4: Introduction to Microsoft Paint & Microsoft Office (16L)

Microsoft Paint: Opening, Drawing & Erasing, Creating a shape, adding text, Opening, cropping, rotating, resizing image, save project (1L)

Microsoft Word: Introduction, Entering text, Editing Document, Formatting Text, Formatting Page, Working with Tables, Mail Merge & Macro (6L)

Microsoft Excel: Introduction, Editing Worksheet, Formatting Cells, Formatting Worksheets, Formulae, Pivot Table (5L)

Microsoft PowerPoint: Introduction, Editing Presentation, Formatting Presentation, Working with multimedia (2L)

Microsoft Access: Overview, Object, Data Type, Create Database, Create Table, Adding Data, Query Data, Action Query (2L)

Module 5: Basic concepts of Operation System, Data Processing, Database System, Data Communication & Network, Internet and Computer Virus (12L)

Operating System: Definition, Function, Evolution, Single User OS, Multiuser OS, Batch Processing, Spooling, Multiprogramming, Multiprocessing, Time sharing, On-line processing, Real time processing, Disk Operating System (DOS), Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers (3L)

Data Processing: Definition, Data Storage Hierarchy, File Organization (Sequential, Direct, Indexed, Index-sequential), File Utilities (Sorting, Searching, Merging, Copying, Printing, Maintenance) (1L)
Database System: Concepts, DBMS, Shortcomings of File Management Systems, Database Structure (List, Hierarchical or Tree, Network, Relational), Advantage & Disadvantages of Database (1L)
Data Communication & Network: Basic Elements, Data Transmission Modes (Simplex, Half Duplex, Full Duplex), Data Transmission Speed (Narrowband, Voice band, Broadband), Transmission Media (Twisted Pair, Coaxial Cable, Microwave system, Communications Satellite, Optical Fibbers), Digital and Analog Transmission (Amplitude Modulation, Frequency Modulation, Phase Modulation), Switching Techniques (Circuit, Message, Packet), Network Topologies (Star, Ring, Mesh, Hybrid), PAN, LAN, MAN, WAN, World Wide Web (WWW), Network Security, Firewall (5L)
Internet: Definition, Search engines, E-mail, Chat (1L)
Computer Virus: Overview, Symptoms, Effect, Precautions (1L)

Text / Reference Books:

1. Computer Fundamentals – P K Sinha, BPB
2. Xavier C Introduction to Computers, New Age International
3. Computer Today by S. K. Basandra, Galgotia Publications, New Delhi
4. Rajaraman V. Fundamental of Computers
5. M.M.Oka Computer Fundamentals, EPH
6. Leon – Fundamental of Information Tchnology, Vikas
7. Ram B. Computer Fundamentals, New Age International

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	1	2	2	3	3	-	-	-
CO2	1	1	2	1	-	2	2	3	3	-	-	-
CO3	1	1	1	3	-	2	2	1	3	-	-	-
CO4	2	1	1	1	1	-	-	3	2	2	-	-
CO5	2	1	1	1	1	-	-	2	1	1	-	-

Course Code	XCA1103			
Course Title	Computer Fundamentals Laboratory			
Category	GE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	Basic idea of Computer			

Learning objectives:

To understand the working of different operating systems like DOS, Windows, Linux/Unix.
To know the different operations of Microsoft Paint.
To able to create tables and others operation in Microsoft Word.
To understand several operations like formulae, pivot table in Microsoft Excel.
To able to create presentation using Microsoft PowerPoint.

Course Outcome:

CO1: Understanding working of different operating systems like DOS, Windows, Linux/Unix.
CO2: Knowledge of different operations of Microsoft Paint.
CO3: Idea to create tables and others operation in Microsoft Word.
CO4: Understanding several operations like formulae, pivot table in Microsoft Excel.
CO5: Understanding to create presentation using Microsoft PowerPoint.

Suggestive list of experiments:

1. Operation of several Windows desktop elements, Start menu, Taskbar, working with files, Notepad, WordPad, setting up and maintain new printer. **[1 day]**
2. Different steps and operation of Microsoft Calculator and Microsoft Paint, Microsoft DOS Commands. **[1 day]**
3. Getting started and File management of Unix/Linux. **[1 day]**
4. Directory management and File permission / access mode of Unix/Linux. **[1 day]**
5. Getting started with Microsoft Word, Entering text, editing document, working with tables. **[1 day]**
6. Formatting text and formatting pages of Microsoft Word, Mail merge & macros. **[1 day]**
7. Introduction of Microsoft Excel, editing worksheets, formatting cells. **[1 day]**
8. Formatting worksheets, formulae and pivot table of Microsoft Excel. **[1 day]**
9. Introduction of Microsoft PowerPoint, Editing presentation. **[1 day]**
10. Formatting presentation of Microsoft PowerPoint, Working with Multimedia. **[1 day]**
11. Overview, Objects, Data types of Microsoft Access, Create Database, Create Tables, adding data to the tables. **[1 day]**
12. Query Data and action queries of Microsoft Access. **[1 day]**

Text / Reference Books:

1. Step by step Word 2010 – Joyce Cox, Joan Preppernau, MICROSOFT

2. Microsoft Excel step by step – Fyre, PHI

3. Step by step PowerPoint 2010 – Joyce Cox, Joan Lambert, MICROSOFT

4. Step by step Access 2010 – Joyce Cox, Joan Preppernau, MICROSOFT

5. MS DOS 6.22 – Russell A. Stultz, BPB

6. Linux In Easy Steps by Mike McGrath, BPB

7. Microsoft Word 2010 In Depth – Faithe Wempen, QUE

8. Microsoft Excel 2010 In Depth – Bill Jelen, QUE

9. Microsoft PowerPoint 2010: Complete – Gary B. Shelly, Course Technology

10. Microsoft Access 2010 In Depth – Roger Jennings, QUE

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	1	-	-	3	2	2	-	-
CO2	1	1	1	1	1	-	-	2	1	1	-	-
CO3	1	1	1	1	1	-	-	3	2	2	-	-
CO4	3	1	1	1	1	-	-	2	1	1	-	-
CO5	3	1	1	1	1	-	-	3	2	2	-	-

Course Code	XED1001			
Course Title	English			
Category	AECC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

The aim of the course is to enable the learner to communicate effectively and appropriately in real life situation and to use English effectively for study purposes

Course outcome:

CO1: Able to familiarize with terms, practices and theoretical foundations of the disciplines

CO2: Able to develop the reading, analytical, and critical skills

CO3: Able to communicate correctly and effectively

Course content:

Module 1: Communication in a Globalized World [4L]

Communication skills: definition and practical dimension. Use of technology in contemporary communication, communication in workplaces. Dimensions of workplace communication: ethics, cross-cultural contexts and virtual contexts.

Module 2: Functional Grammar [8L]

Articles and prepositions. Direct and indirect verbs, subject-verb agreement. Tense and voice, phrases and clauses, direct and indirect speech.

Module 3: Reading Comprehension [6L]

Reading purposes and skills: skimming, scanning and intensive reading. Reading comprehension: fictional and non-fictional prose. One-word substitution and sentence meeting.

Module 4: Writing Skills [6L]

Business emails: enquiry, order, complaint, job application and formal invitations.
Minutes of meeting, proposals, notices. Importance of punctuation in writing.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	-	-	-	3	-	-	2	3
CO2	2	-	1	-	-	-	-	-		-	-	2
CO3	2	-	-	-	-	-	-	3	-	-	-	2

Detail Syllabus B.Sc. Microbiology Semester-2

SEMESTER-2							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI2001	MICROBIAL PHYSIOLOGY AND METABOLISM	3	1	0	4
2	CORE	XMI2002	BACTERIOLOGY	3	1	0	4
3	GE II		GENERAL ELECTIVE II	3	1	0	4
4	AECC II	XBT2003	ENVIRONMENTAL SCIENCE	2	0	0	2
PRACTICAL							
5	CORE	XMI2101	MICROBIAL PHYSIOLOGY AND METABOLISM LAB	0	0	3	2
6	CORE	XMI2102	BACTERIOLOGY LAB	0	0	3	2
7	GE II		GENERAL ELECTIVE II LAB	0	0	3	2
TOTAL				**11**	**3**	**9**	**20**

Course Code	XMI2001			
Course Title	Microbial physiology and metabolism			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: Will have got acquainted with the diverse physiological groups of bacteria/archaea and microbial transport systems.

CO2: Will have an in-depth knowledge of patterns of bacterial growth, bacterial growth curve, calculation of generation time and specific growth rate, and effect of the environment on growth.

CO3: Will understand the variety of pathways used by bacteria for energy generation and conservation during growth on glucose under aerobic and anaerobic conditions.

Course Content:

Module 1: Effect of Environment on Microbial Growth [10L]

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve

Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic.

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Module 2: Nutrient uptake and Transport [10L]

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

Module 3: Chemoheterotrophic Metabolism - Aerobic Respiration [10L]

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

Module 4: Chemoheterotrophic Metabolism [10L]

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

Module 5: Chemolithotrophic and Phototrophic Metabolism [6L]

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

Module 6: Nitrogen Metabolism - an overview [2L]

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

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI2101			
Course Title	Microbial Physiology And Metabolism Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course outcome:

CO1: To understand the basic cell culture and microscopy.

CO2: To explain the theory behind the practical parts in the course and be able to compile and interpret experimental results in both written and oral form.

CO3: To inculcate the spirit of research in young minds.

CO4: To understand the molecular dynamics of cell.

Suggestive list of experiments:

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods. **[2 days]**

2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data **[1 day]**

3. Effect of temperature on growth of *E. coli* **[2 days]**

4. Effect of pH on growth of *E. coli* **[2 days]**

5. Effect of carbon and nitrogen sources on growth of *E.coli* **[2 days]**

6. Effect of salt on growth of *E. coli* **[2 days]**

7. Demonstration of alcoholic fermentation **[2 days]**

8. Demonstration of the thermal death time and decimal reduction time of E. coli. **[2 days]**

Text / Reference Books:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons

3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India

4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	2
CO2	1	1	1	1	1	-	-	2	1	1	-	-
CO3	1	1	1	1	1	-	-	3	2	2	-	-
CO4	3	1	1	1	1	-	-	2	1	1	-	-

Course Code	XMI2002			
Course Title	Bacteriology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of bacteriology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Bacteriology.

Course Outcome:

CO1: Will have gained knowledge about structure and organisation of different cell components of bacteria. Will be able to differentiate between Gram positive and Gram-negative bacteria; archaebacteria and eubacteria cell wall and cell membrane.

CO2: Will get familiar with various media and techniques used for cultivation and maintenance of different types of bacteria.

CO3: Will also gain insight into different phases of growth in batch culture and binary fission as a method of reproduction.

CO4: Will understand the concept of different types of classification. Will learn about the morphology, ecological significance and economic importance of the various bacterial genera.

Course Content:

Module 1: Cell organization [10L]

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Module 2: Bacteriological Techniques [8L]

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.

Module 3: Microscopy [8L]

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

Module 4: Growth and nutrition [8L]

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media *Physical methods of microbial control*: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation *Chemical methods of microbial control*: disinfectants, types and mode of action

Reproduction in Bacteria No. of Hours: 3 Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Module 5: Bacterial systematics [8L]

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

Module 6: Important archaeal and eubacterial groups [8L]

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

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: *Gram Negative:*Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples *Gram Positive:* Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples *Cyanobacteria*: An Introduction

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI2102			
Course Title	Bacteriology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	2	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of bacteriology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Bacteriology.

Course Outcome:

CO1: Knowledge of the various staining procedures and structures of the microorganisms.

CO2: Understand the theoretical basis of the tools, technologies and methods common to the bacterial growth.

CO3: Ability to tabulate and classify bacteria causing economic losses in farm animals.

CO4: Use the scientific approach for prevention, control and suggestion of treatment for microbial infections.

Suggestive List of Experiments:

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar. [2 days]
2. Simple staining [1 day]
3. Negative staining [1 day]
4. Gram's staining [1 day]
5. Acid fast staining-permanent slide only. [1 day]
6. Capsule staining [1 day]
7. Endospore staining. [1 day]
8. Isolation of pure cultures of bacteria by streaking method. [1 day]
9. Preservation of bacterial cultures by various techniques. [1 day]
10. Estimation of CFU count by spread plate method/pour plate method. [1 day]
11. Motility by hanging drop method. [1 day]

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XCH2005			
Course Title	Bio-Analytical Tools			
Category	GE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course outcome:

CO1: To be able to use selected analytical techniques.

CO2: Familiarity with working principals, tools and techniques of analytical techniques.

CO3: To understand the strengths, limitations and creative use of techniques for problem-solving.

Course Content:

Module 1: [12L]

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

Module 2: [12L]

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

Module 3: [12L]

Introduction to the principle of chromatography . Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

Module 4: [12L]

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

Text / Reference Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	2	-	-	-	-	-	-	-	3
CO2	2	3	-	-	2	-	-	-		-	-	2
CO3	2	2	2	-	-	-	-	-	-	-	-	2

Course Code	XCH2105			
Course Title	Bio-Analytical Tools Laboratory			
Category	GE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course outcome:

CO1: To be able to use selected analytical techniques.

CO2: Familiarity with working principals, tools and techniques of analytical techniques.

CO3: To understand the strengths, limitations and creative use of techniques for problem-solving.

Suggestive list of experiments:

1. Native gel electrophoresis of proteins **[1 day]**
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions. **[2 day]**
3. Preparation of the sub-cellular fractions of rat liver cells. **[1 day]**
4. Preparation of protoplasts from leaves. **[1 day]**
5. Separation of amino acids by paper chromatography. **[1 day]**
6. To identify lipids in a given sample by TLC. **[1 day]**
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH. **[1 day]**

Text / Reference Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

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

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Course Code	XBT2003			
Course Title	Environmental Science			
Category	AECC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

To give students an understanding of how science and the scientific method work to address environmental problems. The student will become familiar with the Earth's major systems (ecosystems and biogeochemical cycles), how they function and how they are affected by human activity (population growth, air, water and soil pollution, ozone depletion, global warming, solid waste disposal).

Course outcome:

CO1: Able to articulate the interconnected and interdisciplinary nature of environmental studies

CO2: Able to demonstrate an integrative approach to environmental issues with a focus on sustainability

CO3: Able to communicate complex environmental information to both technical and non-technical audiences

CO4: Able to understand and evaluate the global scale of environmental problems

Course content:

Module 1: General [6L]

1.1 Natural Resources: Forest Resource, water resource, mineral resource, energy resources (renewable,non-renewable, potentially renewable)

1.2 Population Growth: Exponential Growth, logistic growth, Maximum sustainable yield

1.3 Disaster Management: Types of disasters (Natural & Man-made), Floods, Earthquake, Tsunamis, Cyclones, landslides (cause, effect & control)

1.4 Ecology & Ecosystem: Elements of ecology, definition of ecosystem- components types and function, Food chain & Food web,

Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems

1.5 Environmental Management: Environmental impact assessment, Environmental laws and protection act of India, Different international environmental agreement.

Module 2: Air pollution and control [6L]

2.1 Sources of Pollutants: point sources, nonpoint sources and manmade sources primary & secondary pollutant

2.2 Types of air pollutants: primary & secondary pollutant ; Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN, Smog (Photochemical smog and London smog),

2.3 Effects on human health & climate: Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion

2.4 Air pollution and meteorology: Ambient Lapse Rate, Adiabatic Lapse Rate, Atmospheric stability & Temperature inversion

2.5 control of air pollution (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury),

Module 3: Water Pollution [6L]

3.1 Classification of water (Ground & surface water)

3.2 Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, heavy metals, pesticides, volatile organic compounds.

3.3 Surface water quality parameters: pH, DO, 5 day BOD test, BOD reaction rate constants, COD. Numerical related to BOD Lake: Eutrophication [Definition, source and effect].

3.4 Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only),ground water pollution (Arsenic & Fluoride; sources, effects, control)

3.5 Quality of Boiler fed water: DO, hardness , alkalinity, TDS and Chloride

3.7 Layout of waste water treatment plant (scheme only).

Module 4: Land Pollution [2L]

4.1 Types of Solid Waste: Municipal, industrial, commercial, agricultural, domestic, hazardous solid wastes (bio-medical), E-waste

4.2 Solid waste disposal method: Open dumping, Land filling, incineration, composting, recycling (Advantages and disadvantages).

Module 5: Noise Pollution [2L]

5.1 Definition of noise, effect of noise pollution on human health,

5.2 Average Noise level of some common noise sources

5.3 Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L10 (18 hr Index) .

5.4 Noise pollution control.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	-	-	-	-	-	-	-	-	3
CO2	2	-	1	-	-	3	-	-	2	-	-	2
CO3	2	-	-	-	-	2	-	3	-	-	-	2
CO4	-	-	2	-	-	2	-	-	2	-	-	2

Detail Syllabus BSc Microbiology Semester-3

SEMESTER-3							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI3001	MICROBIAL GENETICS	3	1	0	4
2	CORE	XMI3002	MOLECULAR BIOLOGY	3	1	0	4
3	CORE	XMI3003	ENVIRONMENTAL MICROBIOLOGY	3	1	0	4
4	GE III		GENERAL ELECTIVE III	3	1	0	4
5	SEC I		SKILL ENHANCE COURCES I	2	0	0	2
6	AECC III	XBB3009	ENTREPRENEURSHIP DEVELOPMENT	2	0	0	2
PRACTICAL							
7	CORE	XMI3101	MICROBIAL GENETICS LAB	0	0	3	2
8	CORE	XMI3102	MOLECULAR BIOLOGY LAB	0	0	3	2
9	CORE	XMI3103	ENVIRONMENTAL MICROBIOLOGY LAB	0	0	3	2
10	GE III		GENERAL ELECTIVE III LAB	0	0	3	2
TOTAL				**16**	**4**	**12**	**28**

Course Code	XMI3001			
Course Title	Microbial Genetics			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0 0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbial genetics and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of genetics.

Course Outcome:

CO1: Will be acquainted with the organization of prokaryotic and eukaryotic genomes and organelle genomes in eukaryotes

CO2: Will get acquainted with basic and applied aspects of mutations and mutagenesis and their importance and the role of mutator genes. Will learn of the use of a microbial test in detecting the carcinogenic potential of chemicals. Will become aware of different repair mechanisms.

CO3: Will have learnt the role of plasmids and their types in microorganisms. Will get acquainted with plasmid replication and partitioning as well as aspects related to plasmid copy number, its regulation and plasmid curing.

Course Content:

Module 1: Genome Organization and Mutations [10L]

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

Module 2: Plasmids [10L]

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Module 3: Mechanisms of Genetic Exchange [10L]

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

Module 4: Phage genetics [8L]

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

Module 5: Transposable element [10L]

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

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI3101			
Course Title	Microbial Genetics Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbial genetics and their experimental basis, and to enable students to acquire hands on training.

Course Outcome:

CO1: Will develop the knowledge to perform basic experiments in microbial genetics

CO2: Will be able to investigate interesting biological problems

CO3: Will develop the insight into current topics in microbial genetics and related fields.

Suggestive List of Experiments:

1. Preparation of Master and Replica Plates **[2 days]**
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells **[2 days]**
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light **[1 day]**
4. Isolation of Plasmid DNA from *E.coli* **[1 day]**
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis. **[1 day]**
6. Demonstration of Bacterial Conjugation **[1 day]**
7. Demonstration of bacterial transformation and transduction **[1 day]**
8. Demonstration of AMES test **[1 day]**

Text / 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, 6th Ed., Benjamin Cummings

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI3002			
Course Title	Molecular Biology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

Demonstrate a good knowledge base in biological concepts and be able to integrate knowledge with critical thinking skills to become problem solvers.

Course outcome:

CO1: In-depth knowledge on how cellular machinery works, especially the proteins factors orchestrating the processes.

CO2: Formulate and carry out independent and collaborative research projects.

CO3: Demonstrate a commitment to professional integrity and ethical behaviour consistent with the mission of the university and accepted standards of professional conduct.

CO4: Present hypotheses and select, adapt and conduct molecular and cell-based experiments to either confirm or reject the hypotheses.

CO5: Understand and apply the principles and techniques of molecular biology which prepares students for further education, basic and applied research, and/or as health professionals.

Course content:

Module 1: Structures of DNA and RNA / Genetic Material [10L]

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Module 2: Replication of DNA (Prokaryotes and Eukaryotes) [8L]

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

Module 3: Transcription in Prokaryotes and Eukaryotes [8L]

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

Module 4: Post-Transcriptional Processing [6L]

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

Module 5: Translation (Prokaryotes and Eukaryotes) [8L]

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote

Module 6: Regulation of gene Expression in Prokaryotes and Eukaryotes [8L]

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

Text / 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

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

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

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

5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 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

7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	-	-	-	-	-	-	-	-	-	3

CO2	2	1	-	-	3	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	3	-	-	2	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-	-

Course Code	XMI3102			
Course Title	Molecular Biology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

Demonstrate a good knowledge base in biological concepts and be able to integrate knowledge with critical thinking skills to become problem solvers

Course outcome:

CO1: Independently execute a laboratory experiment using the standard methods and techniques in molecular biology, with the appropriate analysis and interpretation of results obtained.
CO2: Apply the fundamental rules for occupational safety in the laboratory, with the proper use and maintenance of equipment.
CO3: Equip the students with molecular tools to enable their laboratory skills and troubleshooting mechanisms to become a competent molecular biologist.
CO4: Ability to correlate theoretical aspects of molecular phenomena to finding practical basis of life and its maintenance.

Suggestive list of experiments:

Study of different types of DNA and RNA using micrographs and model / schematic representations **[1 day]**

Study of semi-conservative replication of DNA through micrographs / schematic representations **[1 day]**

Isolation of genomic DNA from *E. coli* **[1 day]**

Estimation of salmon sperm / calf thymus DNA using colorimeter(diphenylamine reagent) or UV spectrophotometer (A260 measurement) **[2 days]**

Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement) **[2 days]**

Resolution and visualization of DNA by Agarose Gel Electrophoresis. **[1 day]**

Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE). **[2 days]**

Text / 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

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

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

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

5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 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

7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	-	-	-	-	-	-	-	-	-	3
CO2	2	1	-	-	3	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	3	-	-	2	-	-

Course Code	XMI3003			
Course Title	Environmental Microbiology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of environmental microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: Will get acquainted with natural habitats of diverse microbial population and be familiar with microbial succession.

CO2: Will understand how microbes interact among themselves and with higher plants and animals with the help of various examples.

CO3: Will become aware of the important role microorganisms play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance.

Course Content:

Module 1: Microorganisms and their Habitats [10L]

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

Module 2: Microbial Interactions [10L]

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

Module 3: Biogeochemical Cycling [10L]

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

Module 4: Waste Management **[10L]**

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

Module 5: Microbial Bioremediation **[2L]**

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

Module 6: Water Potability **[8L]**

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

Text / 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.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI3103			
Course Title	Environmental Microbiology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of microbiology and their experimental basis

Course Outcome:

CO1: Will be familiar with the soil analysis techniques.

CO2: Illustrate the distribution of soil microflora and their impact on soil quality.

CO3: Identify the diverse microflora of water and assess their significance in water treatment, water pollution and water quality.

Suggestive List of Experiments:

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action. **[1 Day]**
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC) **[2 days]**
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane. **[2 days]**
4. Assessment of microbiological quality of water. **[2 days]**
5. Determination of BOD of waste water sample. **[2 days]**
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil. **[2 days]**
7. Isolation of Rhizobium from root nodules. **[1 day]**

Text / Reference Books:

1. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
2. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
3. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XCH3001			
Course Title	Chemistry			
Category	GE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

Chemistry plays a pivotal role to understand the molecular level structure and its corresponding activity. This course builds up the basic theoretical foundations of chemistry in context of chemical bonding, fundamentals of organic chemistry and also to generate in depth knowledge of thermodynamics, chemical equilibria and ionic equilibria so that they can explain different facet of a phenomena either in macroscopic or microscopic world.

Course Outcome:

CO1: Classify the inorganic compounds in terms of bonding and will be able to predict the geometry of the molecule
CO2: Determine the number of unpaired electron present in a molecule/ions and thereby able to evaluate magnetic properties of the molecule/ions
CO3: Understand about reaction intermediates, their stability and mode of activity
CO4: Predict the stereochemistry of a compound with respect to isomerism, conformation, and their nomenclature
CO5: To apply thermodynamics to explain the physical, chemical and biological phenomena
CO6: To predict the effect of reactant(s), temperature and introduction of inert substance in a process

Course Content:

Module 1: Inorganic Chemistry

Ionic Bonding: General characteristics of ionic bonding, lattice energy, solvation energy, Born- Haber cycle and its applications, polarizing power, polarizability: Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage of ionic character.
Covalent bonding: Shapes of inorganic molecules with suitable examples, MO of diatomic molecules, concept of resonance and resonating structures in various inorganic and organic compounds.
Van der Waals interactions, hydrophilic and hydrophobic interactions, importance of hydrogen bonds in biomolecules, directionality of hydrogen bonding.

Module 2: Organic Chemistry

Fundamentals, electronic displacements: Inductive Effect, Electromeric effect, Resonance Hyper-conjugation and their applications, Dipole moment, Reactive intermediates: carbocations, carbanions, carbene, free radical, and benzyne, Aromaticity.
Nucleophilic substitution reactions, Elimination reactions: Saytzeff's and Hoffmann rule, addition reactions to alkene and alkyne: Markownikoff's and anti-Markownikoff's addition, Hydration, Ozonolysis, oxymecuration-demercuration.

Stereochemistry: conformations with respect to ethane and butane, Inter conversion of Wedge Formula, Newmann, Sawhorse and Fischer representations, Concept of chirality, Configuration: Geometrical and Optical isomerism, Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro, D and L, cis–trans nomenclature, CIP Rules: R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C=C systems).

Module 3: Physical Chemistry

Chemical Energetics: Laws of Thermodynamics and their applications, thermochemistry and its applications.
Chemical Equilibrium: Equilibrium constants, relationships between K_p, K_c and K_x for reactions involving ideal gases. Le Chatelier's principle, free energy change in a chemical reaction.
Ionic Equilibrium: Classifications of electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant, ionic product of water, p^H scale, Solubility product: principle and its applications, salt hydrolysis, buffer, buffer capacity, Henderson equation and related problems, principle of choice of indicators for acid-base titration with examples.

Text/Reference books:

1. J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
2. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
3. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
4. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
5. R. G. Mortimer, Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
6. P.C. Rakshit, Physical Chemistry 7th Ed. Sarat book distributors, Calcutta (2001)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	-	-	-	-	-	-	-	-	2
CO2	2	2	2	2	2	-	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	2	3	2	-	-	-	-	-	-	-	-	1
CO5	3	2	3	2	2	2	-	-	-	-	-	2
CO6	3	3	2	2	2	-	-	-	-	-	-	2

Course Code	XCH3101			
Course Title	Chemistry Practical			
Category	GE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

To provide hand on laboratory experience in volumetric analysis, detection of elements in organic compounds and separation of organic mixtures by paper chromatography.

Course Outcome:

CO1: To estimate inorganic and organic compounds volumetrically

CO2: To identify extra elements (N, S, Cl, Br, I) in organic compounds

CO3: To determine heat capacity of calorimeter and enthalpy of neutralization

CO4: To prepare and measure the buffer solution of a particular pH

Suggestive list of experiments:

Inorganic Chemistry

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. [1 day]
2. Estimation of oxalic acid by titrating it with $KMnO_4$. [2 days]

Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements). [5 days]

Physical Chemistry

1. Determination of heat capacity of calorimeter for different volumes. [1 day]
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. [1 day]
3. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter. [1 day]
4. Preparation of buffer solutions: Sodium acetate-acetic acid. [1 day]

5. Text/Reference books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical OrganicChemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
6. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
7. G. N. Mukherjee, Handbook of Practical Chemistry

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	3	-	-	-	-	-	-	-	2
CO2	2	2	2	3	2	-	-	-	-	-	-	2
CO3	3	2	2	3	-	-	-	-	-	-	-	2
CO4	2	2	2	3	2	2	-	-	-	-	-	2

Course Code	XMI3004			
Course Title	Microbial Quality Control in Food and Pharmaceutical Industries			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Microbial Quality Control in Food and Pharmaceutical Industries

Course Outcome:

CO1: Learn basics of infection and the epidemiology of infectious diseases.

CO2: Understand the morphology, pathogenicity and laboratory diagnosis of gram positive and negative organisms.

CO3: Study the morphology, pathogenicity and laboratory diagnosis of acid-fast bacteria.

CO4: Acquire basic knowledge about the pathogenicity and laboratory diagnosis of fungal and protozoan pathogens.

Course Content:

Module 1: Microbiological Laboratory and Safe Practices [6L]

Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL- 1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Module 2: Determining Microbes in Food / Pharmaceutical Samples [6L]

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products; Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Module 3: Pathogenic Microorganisms of Importance in Food & Water [6L]

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

Module 4: HACCP for Food Safety and Microbial Standards [6L]

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

Text / Reference Books:

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI3005			
Course Title	Microbial Diagnosis In Health Clinics			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of clinical microbiology

Course Outcome:

CO1: Learn basics of infection and the epidemiology of infectious diseases.

CO2: Understand the morphology, pathogenicity and laboratory diagnosis of gram positive and negative organisms.

CO3: Study the morphology, pathogenicity and laboratory diagnosis of acid-fast bacteria.

CO4: Acquire basic knowledge about the pathogenicity and laboratory diagnosis of fungal and protozoan pathogens.

Course Content:

Module 1: Importance of Diagnosis of Diseases [4L]

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Module 2: Collection of Clinical Samples [4L]

How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Module 3: Direct Microscopic Examination and Culture. [4L]

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa- stained thin blood film for malaria

Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Module 4: Serological and Molecular Methods [4L]

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Module 5: Kits for Rapid Detection of Pathogens [4L]

Typhoid, Dengue and HIV, Swine flu

Module 6: Testing for Antibiotic Sensitivity in Bacteria [4L]

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

Text / 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. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	1
CO3	-	2	2	1	1	1	-	-	-	-	-	1
CO4	1	2	2	1	-	3	-	-	1	-	1	1

Course Code	XMI3006			
Course Title	Biofertilizers And Biopesticides			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of biofertilizers and biopesticides

Course Outcome:

CO1: Learn basics of Biofertilizer.

CO2: Understand biofertilizer preparation

CO3: Study of biopesticide.

CO4: Study the effect of biofertilizer and biopesticide.

Course Content:

Module 1: Biofertilizers [5L]

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants

Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Module 2: Non - Symbiotic Nitrogen Fixers [5L]

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application

Module 3: Phosphate Solubilizers [5L]

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Module 4: Mycorrhizal Biofertilizers [5L]

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Module 5: Bioinsecticides [4L]

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

Text / Reference Books:

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	1
CO3	-	2	2	1	1	1	-	-	-	-	-	1
CO4	1	2	2	1	-	3	-	-	1	-	1	1

Course Code	XBB3009			
Course Title	Entrepreneurship Development			
Category	AECC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

The students will be able to develop and can systematically apply an entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.

Course outcome:

CO1: Able to detect distinct entrepreneurial traits

CO2: Able to understand the parameters to assess opportunities for new business ideas

CO3: Able to design strategies for successful implementation of ideas

CO4: Able to write a business plan

Course content:

Module 1: Introduction [6L]

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

Module 2: Establishing an Enterprise [4L]

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

Module 3: Financing the Enterprise [6L]

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

Module 4: Marketing Management [4L]

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

Module 5: Entrepreneurship and International Business [4L]

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	2	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	2	-	-	2	-
CO3	-	-	3	-	-	-	-	1	-	-	2	-
CO4	1	-	-	-	2	-	-	2	-	-	2	-

Detail Syllabus BSc Microbiology Semester-4

SEMESTER-4							
Sl. No	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI4001	BIOINFORMATICS	3	1	0	4
2	CORE	XMI4002	IMMUNOLOGY	3	1	0	4
3	CORE	XMI4003	MEDICAL MICROBIOLOGY	3	1	0	4
4	GE IV		GENERAL ELECTIVE IV	3	1	0	4
5	SEC II		SKILL ENHANCE COURCES II	2	0	0	2
6	AECC IV		VALUES AND ETHICS	2	0	0	2
PRACTICAL							
7	CORE	XMI4101	BIOINFORMATICS LAB	0	0	3	2
8	CORE	XMI4102	IMMUNOLOGY LAB	0	0	3	2
9	CORE	XMI4103	MEDICAL MICROBIOLOGY LAB	0	0	3	2
10	GE IV		GENERAL ELECTIVE IV LAB	0	0	3	2
TOTAL				**16**	**4**	**12**	**28**

Course Code	XMI4001			
Course Title	Bioinformatics			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Bioinformatics and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of bioinformatics.

Course Outcome:

CO1: Generate interdisciplinary thinking towards advances in bioinformatics.

CO2: Informed and trained incumbents to the use of computational tools and approaches to extract information from different types of bioinformatics data (gene, protein, disease, etc.) and to analyse them in their area of future research work.

CO3: Develop an understanding of algorithms of sequence alignment (pair-wise and multiple) and scoring algorithms

CO4: Develop basic understanding of how biological data is stored and retrieved from various biological databases.

Course Content:

Module 1: Introduction to Computer Fundamentals [2L]

RDBMS - Definition of relational database; Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

Module 2: Introduction to Bioinformatics and Biological Databases [10L]

Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms; General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Module 3: Sequence Alignments, Phylogeny and Phylogenetic trees [10L]

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

Module 4: Genome organization and analysis **[6L]**

RDBMS - Definition of relational database; Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

Module 5: Protein Structure Predictions **[10L]**

Hierarchy of protein structure - primary, secondary and tertiary structures, modelling Structural Classes, Motifs, Folds and Domains; Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot; Protein structure and rational drug design.

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-				

Course Code	XMI4101			
Course Title	Bioinformatics Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Bioinformatics and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of bioinformatics.

Course Outcome:

CO1: Inculcate sound practical interdisciplinary skills at pursuing in advances of relevance to bioinformatic approaches founding living systems.

CO2: Capacity to create and apply bioinformatic tools and approaches to extract information from different types of biobig data (gene, protein, disease, and so on).

CO3: Develop an understanding of algorithms of sequence alignment (pair-wise and multiple) and scoring algorithms.

CO4: Inquisitiveness on how bio bigdata is stored and retrieved from various biological databases.

Suggestive List of Experiments:

8. Introduction to different operating systems - UNIX, LINUX and Windows [**1 day**]
9. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB [**2 days**]
10. Sequence retrieval using BLAST [**2 days**]
11. Sequence alignment & phylogenetic analysis using clustalW & phylip [**2 days**]
12. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool [**2 days**]

13. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)

[**2 days**]

14. Prediction of different features of a functional gene

[**2 days**]

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-				

Course Code	XMI4002			
Course Title	Immunology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Immunology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Immunology.

Course Outcome:

CO1: Ability to conceptualize the basic mechanisms that regulate immune responses and maintain tolerance

CO2: Understanding of the molecular basis of complex, cellular processes involved in inflammation and immunity, in states of health and disease.

CO3: Ability to translate understanding of basic mechanisms into identification of biological, clinical and therapeutic implications.

CO4: Knowhow of basic and state-of-the-art experimental methods and technologies to study of immunology.

Course Content:

Module 1: Introduction **[5L]**

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

Module 2: Immune cells and organs **[3L]**

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

Module 3: Antigens **[5L]**

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

Module 4: Antibodies **[5L]**

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

Module 5: MHC complex **[5L]**

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

Module 6: Complement system **[5L]**

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

Module 7: Generation of Immune response **[5L]**

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

Module 8: Immunological Disorders and Tumor Immunity **[5L]**

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

Module 9: Immunological techniques **[5L]**

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

Text / 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.

4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI4102			
Course Title	Immunology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Immunology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Immunology.

Course Outcome:

CO1: Capability to provide an overview of the interaction between the immune system and pathogens.

CO2: Sound hands on training for various immunological techniques.

CO3: Demonstrate proper operation of the equipment and instruments used in this course.

CO4: Enhanced Problem solving, creative thinking, and communication of immunological phenomenon at academia, industry and R&D settings.

Suggestive List of Experiments:

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

Text / Reference Books:

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

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

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

Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-				

Course Code	XMI4003			
Course Title	Medical Microbiology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Medical Microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Medical Microbiology.

Course Outcome:

CO1: Learn basics of infection and the epidemiology of infectious diseases.

CO2: Understand the morphology, pathogenicity and laboratory diagnosis of gram positive and negative organisms.

CO3: Study the morphology, pathogenicity and laboratory diagnosis of acid-fast bacteria.

CO4: Acquire basic knowledge about the pathogenicity and laboratory diagnosis of fungal and protozoan pathogens.

Course Content:

Module 1: Normal microflora of the human body and host pathogen interaction [8L]

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

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

Module 2: Sample collection, transport and diagnosis [5L]

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

Module 3: Bacterial diseases [5L]

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

Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae, Mycobacterium*

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

Module 4: Viral diseases [5L]

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

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

Module 5: Protozoan diseases [5L]

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

Module 6: Fungal diseases [5L]

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

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

Module 7: Antimicrobial agents: General characteristics and mode of action [5L]

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

Module 9: Immunological techniques [5L]

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI4103			
Course Title	Medical Microbiology Laboratory			
Category	Microbiology			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Medical Microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of Medical Microbiology.

Course Outcome:

CO1: To acquaint with microbial isolation techniques from various clinical samples.

CO2: Gain knowledge about diagnostic tests for diseases.

CO3: To train to determine potency of antibiotics using various standard methods.

CO4: Learn principles underlying diagnostic tests and handle kits for diagnosis of diseases.

Suggestive List of Experiments:

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

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XCS4001			
Course Title	C Programming			
Category	GE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	Basic idea of Computer, Basic programming Language concepts			

Learning objectives:

To develop the programming skills of students.

To know the principles of designing structured programs.

To write basic C programs using: -

- Selection statements
- Repetitive statements
- Functions
- Pointers
- Arrays
- Strings.

Course Outcome:

CO1: Understanding the concept of input and output devices of Computers and how it works and recognize the basic terminology used in computer programming.

CO2: Write, Compile and Debug programs in C language and use different data types for writing the programs.

CO3: Design programs connecting decision structures, loops and functions.

CO4: Explain the difference between call by value and call by address.

CO5: Understand the dynamic behavior of memory by the use of pointers.

Course Content:

Module 1: C Variable, Data type, Operator, Expressions (12L)

Variable and Data Types: The C character set identifiers and keywords, data type & sizes, variable names, declaration, Statements

C Operators & Expressions: Arithmetic operators, relational operators, logical operators, increment and decrement operators,bitwise operators, assignment operators, conditional operators, special operators - typeconversion, C expressions, precedence and associativity.

Input and Output: Standard input and output, formatted output - printf, formatted input scanf

Module 2: Branching and Loop Statements: (10L)

Statement and blocks, if - else, switch, goto and labels

Loops - while, for, do while, break and continue

Module 3: Array. Character Array & Strings (6L)

One dimensional arrays, Two-dimensional arrays, Multidimensional arrays. Passing an array to a function

Character array and string, array of strings, Passing a string to a function, String related functions

Module 4: Function, Structure, Union & Pointers (12L)

auto, external, static and register variables. Functions, function types, function prototypes, functions returning values, functions not returning values, scope rules, recursion

Basic of structures, arrays of structures, structures and pointers, structures and functions, Basics of Unions.

Pointers, Pointer and Array, Pointer and String, Pointer and functions

Module 5: File I/O, Preprocessor, Error Handling, Command-Line Arguments (8L)

formatted and unformatted files, Command line arguments, fopen, fclose, fgetc, fputc, fprintf, fscanf function

typedef, preprocessor, header file, type casting, Error handling

Variable arguments, Memory Management, Dynamic memory allocation

Text / Reference Books:

1. Kerninghan B.W. & Ritchie D.M. - The C Programming Language
2. Gottfried - Programming with C Schaum
3. Kanetkar Y. - Let us C
4. Balaguruswamy - Programming in C
5. Pohl and Kelly - A Book on C
6. Kerninghan, B.W. - The Elements of Programming Style
7. Schied F.S. Theory and Problems of Computers and Programming
6. Ravichandran D. Programming in C, New Age International

7. Xavier C. Introduction to Computers, New Age International

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	3	3	3	-	-	-	-	-	-	-

Course Code	XCS4101			
Course Title	C Programming Laboratory			
Category	GE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	Basic idea of Computer, Basic programming Language concepts			

Learning objectives:

To develop an understanding of the design, implementation, and compilation of a C program.
To gain the knowledge about pointers, a fundamental for understanding data structure issues.
To understand the usage of user defined data type for application development.

Course Outcome:

CO1: Write, Compile and Debug programs in C language.
CO2: Design programs connecting decision structures, loops.
CO3: Exercise user defined functions to solve real time problems.
CO4: Inscribe C programs using Pointers to access arrays, strings, functions, structures and files.
CO5: Write program on Preprocessor, Command-Line arguments, Error Handling, Dynamic memory allocation.

Suggestive list of experiments:

1. Writing C Programs on variable, expression, operator and type-casting. **[1 day]**

2. Writing C Programs using different structures of if-else statement and switch-case statement. **[1 day]**

3. Writing C Programs demonstrating use of loop (for loop, while loop and do-while loop) concept and use of break and continue statement. **[1 day]**

4. Writing C Programs demonstrating concept of Single & Multidimensional arrays.**[1 day]**

5. Writing C Programs demonstrating concept of Character Array & Strings and several build-in string functions. **[1 day]**

6. Writing C Programs demonstrating concept of Function and Recursion. **[1 day]**

7. Writing C Programs demonstrating concept of Pointers, address of operator, declaring pointers and operations on pointers. **[1 day]**

8. Writing C Programs demonstrating concept of structures, union and pointer to structure. **[1 day]**

9. Writing C Programs demonstrating concept of String and command line arguments. **[1 day]**

10. Writing C Programs demonstrating concept of dynamic memory allocation. **[1 day]**

11. Writing C Programs demonstrating concept of File Programming. **[1 day]**

12. Writing c programs demonstrating preprocessor, error handling, variable-length arguments. **[1 day]**

Text / Reference Books:

1. Kerninghan B.W. & Ritchie D.M. - The C Programming Language
2. Gottfried - Programming with C Schaum
3. Kanetkar Y. - Let us C
4. Balaguruswamy - Programming in C
5. Pohl and Kelly - A Book on C
6. Kerninghan, B.W. - The Elements of Programming Style
7. Schied F.S. Theory and Problems of Computers and Programming
8. Ravichandran D. Programming in C, New Age International
9. Xavier C. Introduction to Computers, New Age International

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	2	-	3	-	-	2	-	-	-	-	-	-
CO5	3	-	3	3	3	-	-	-	-	-	-	-

Course Code	XMI4004			
Course Title	Food Fermentation Techniques			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Food fermentation techniques.

Course Outcome:

CO1: Understand the role of different microorganisms in Food undustry

CO2: Learn different fermentation processes used in the food industry

CO3: Understand role of Probiotics in food

Course Content:

Module 1: Fermented foods **[4L]**

Fermented Foods .

Definition, types, advantages and health benefits

Module 2: Milk Based Fermented Foods **[4L]**

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

Module 3: Grain Based Fermented Foods **[4L]**

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

Module 4: Vegetable Based Fermented Foods **[4L]**

Pickels, Saeurkraut: Microorganisms and production process.

Module 5: Fermented Meat and Fish **[4L]**

Types, microorganisms involved, fermentation process

Module 6: Probiotic Foods **[4L]**

Definition, types, microorganisms and health benefits

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI4005			
Course Title	Management Of Human Microbial Diseases			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Management of Human microbial diseases.

Course Outcome:

CO1: learning role of different micro-organisms causing human diseases

CO2: Understanding the molecular mechanisms involved in different microbial diseases.

CO3: Learning about therapeutic strategies used to treat these diseases

Course Content:

Module 1: Human Diseases [6L]

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Module 2: Microbial diseases [6L]

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Module 3: Therapeutics of Microbial diseases [6L]

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides.

Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.

Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Module 4: Prevention of Microbial Diseases [6L]

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XMI4006			
Course Title	Microbiological Analysis Of Air And Water			
Category	Microbiology			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Microbiological analysis of air and water.

Course Outcome:

CO1: Understand the microbiological diversity present in air, water and soil.

CO2: Learning about sample collection methods to analyse the present microbes.

CO3: Learning about control measures.

Course Content:

Module 1: Aero microbiology **[4L]**

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

Module 2: Air Sample Collection and Analysis **[4L]**

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

Module 3: Control Measures **[4L]**

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

Module 4: Water Microbiology **[4L]**

Water borne pathogens, water borne diseases

Module 5: Microbiological Analysis of Water **[4L]**

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

Module 6: Control Measures **[4L]**

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

Text / 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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code				
Course Title	Values and Ethics			
Category	AECC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objective:

The objective of the course is to create an awareness on Ethics and Human Values. This course will instil Moral and Social Values and Loyalty and create awareness on assessment of safety and risk.

Course outcome:

CO1: Able to identify and analyze an ethical issue in the subject matter under investigation or in a relevant field

CO2: Able to identify the multiple ethical interests at stake in a real-world situation or practice

CO3: Able to articulate what makes a particular course of action ethically defensible

CO4: Able to assess their own ethical values and the social context of problems

CO5: Able to identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects

CO6: Able to demonstrate knowledge of ethical values in non-classroom activities, such as service, learning, internships, and field work

Course content:

Module 1: **[2L]**

Ethics and Human Values – Definition – Good Behaviour, Conduct and Character; Importance, Respects for Elders, Use and Relevance in Present-day Society.

Module 2: **[4L]**

Indian Constitution and Values – Fundamental Rights and Duties -Freedom, Equality, Fraternity, Justice; Directive Principles of State Policy; Our National Emblem.

Module 3: **[6L]**

Individual and Society – Desirable Basic Human Characters - Honesty, Truthfulness, Respect, Punctuality, Responsibility, Courtesy, Discipline, Kindness, courage, Character, Forgiveness, Friendship, Compassion, Consideration, Contentedness, Simplicity, Empathy, Avoiding Greed; Family responsibilities; Duties as a Member of the Society; Social Concerns – Evils of Dowry, Caste System, Racial Discrimination; Participation in NCC, NSS, Scouts & Guides, NGC.

Module 4: **[4L]**

Life Skills – Goal-setting; Self-esteem and Self-Confidence; Problem Solving; Decision Making; Time Management; Stress Management; Positive Thinking; Assertiveness; Teamwork; Interpersonal Relationships; Coping with Life Stresses; Suicidal Tendencies; Peer Pressure; Substance Abuse and Addiction.

Module 5: **[4L]**

Environmental Concerns – Respect for Natural Environment – Land, Trees, Air, Water, Animals; Unethical Practices – Depletion of Natural Resources (Soil Erosion, Pollution, Mining, Deforestation); Use of Plastics and Pesticides; EcoClubs.

Module 6: **[2L]**

Professional Ethics–Need and Importance – Goals – Dignity of Labour – Ethical Values in Different Professions – Management, Business, Teaching, Civil Services, Politics, Medicine, Policing, Judiciary.

Module 7: **[2L]**

Ethics, Values and Thinking–Right Thinking, Right Understanding, Reflective Thinking, Rational / Critical Thinking, Creative Thinking.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	2	-	-	2	-	-	2	3	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	2
CO3	-	-	1	-	2	-	-	-	-	-	3	-
CO4	-	-	-	-	-	-	-	-	3	-	-	1
CO5	-	-	2	-	2	3	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	2	-	3

Detail Syllabus BSc Microbiology Semester-5

SEMESTER-5							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI5001	INDUSTRIAL MICROBIOLOGY	3	1	0	4
2	CORE	XMI5002	RECOMBINANT DNA TECHNOLOGY	3	1	0	4
3	DSE I		DISCIPLINE SPECIFIC ELECTIVE I	3	1	0	4
4	DSE II		DISCIPLINE SPECIFIC ELECTIVE II	3	1	0	4
PRACTICAL							
5	CORE	XMI5101	INDUSTRIAL MICROBIOLOGY LAB	0	0	3	2
6	CORE	XMI5102	RECOMBINANT DNA TECHNOLOGY LAB	0	0	3	2
7	DSE I		DISCIPLINE SPECIFIC ELECTIVE I LAB	0	0	3	2
8	DSE II		DISCIPLINE SPECIFIC ELECTIVE II LAB	0	0	3	2
TOTAL				**12**	**4**	**12**	**24**

Course Code	XMI5001			
Course Title	Industrial Microbiology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Industrial Microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: Understand that microorganisms play a vital role to all forms of life on earth.

CO2: Screen and isolate beneficial microorganisms from the environment.

CO3: Gain theoretical knowledge on production of microbial products.

CO4: Acquire theoretical and technical knowledge on microbial production of health care products.

Course Content:

Module 1: Introduction to Industrial Microbiology [8L]

Brief history and developments in industrial microbiology

Module 2: Isolation of industrially important microbial strains and fermentation media [8L]

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

Module 3: Types of fermentation processes, bio-reactors and measurement of fermentation parameters [8L]

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

Module 4: Down-stream processing **[8L]**

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

Module 5: Production **[8L]**

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, lipase) Wine, beer

Module 6: Enzyme immobilization **[8L]**

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

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	-	2	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	1	1	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	1	-	-
CO4	1	2	2	1	-	3	-	-				

Course Code	XMI5101			
Course Title	Industrial Microbiology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Industrial Microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: To analyse the potency of an antibiotic by suitable bioassay.

CO2: To study the stoichiometric evaluation of enzyme activity.

CO3: To handle the techniques involved in enzyme immobilization.

CO4: Design bioprocesses for commercially valuable products.

Suggestive List of Experiments:

1. Study different parts of fermenter [1 day]
2. Microbial fermentations for the production and estimation (qualitative and quantitative) [1 day]
3. Enzymes: Amylase and Protease [2 days]
4. Amino acid: Glutamic acid [2 days]
5. Organic acid: Citric acid [2 days]
6. Alcohol: Ethanol [2 days]
7. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations. [2 days]

Text / 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 Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	-	2	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	1	1	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	1	-	-
CO4	1	2	2	1	-	3	-	-				

Course Code	XMI5002			
Course Title	Recombinant DNA Technology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of recombinant DNA technology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of recombinant DNA technology.

Course Outcome:

CO1: Understand genomic organization of prokaryotes including bacterial chromosome, plasmids and transposable genetic material

CO2: Understand gene transfer mechanism in prokaryotes, its applications and genetic make-up of bacteriophage and yeast briefly

CO3: Explain molecular mechanism underlying mutations and useful phenotypes of bacterial mutants.

CO4: Explain the basics and molecular techniques involved in recombinant DNA technology and the role of microbes in rDNA technology

Course Content:

Module 1: Introduction to genetic engineering [4L]

Milestones in genetic engineering and biotechnology

Module 2: Molecular Cloning- Tools and Strategies [12L]

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

Module 3: Methods in molecular cloning [6L]

Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection,

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

Module 4: DNA Amplification and DNA sequencing **[8L]**

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

Module 5: Genomic libraries **[9L]**

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

Module 6: Applications of RDT **[9L]**

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

Text / 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
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-

CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI5102			
Course Title	Recombinant DNA Technology Laboratory			
Category	Microbiology			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of recombinant DNA technology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of recombinant DNA technology.

Course Outcome:

CO1: Study about Recombinant DNA Technology and its role in industries.

CO2: Impart knowledge about techniques in Recombinant DNA Technology..

CO3: Learn about production of Recombinant products.

CO4: Know about emerging techniques in Recombinant DNA Technology

Suggestive List of Experiments:

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

Text / 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
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	-	-	-	-	-	-
CO3	-	2	2	1	1	-	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI5003			
Course Title	Microbial Biotechnology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view at how microbes and their metabolic pathways and products can be utilised in biotechnology. The areas of particular concern such as Environmental biotechnology, bioremediation and biomining will also help to grow the interest of the students in the other aspects of biotechnology.

Course outcome:

CO1: Able to demonstrate a familiarity with the wide diversity of microbes.

CO2: Able to gain knowledge about the potential of microbes for use in microbial biotechnology.

CO3: Able to demonstrate a knowledge of microbial gene.

CO4: Able to describe genome structure and function, and how these can be manipulated.

Course Content:

Module 1: Microbial Biotechnology and its Applications [9L]

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology; Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Module 2: Therapeutic and Industrial Biotechnology [9L]

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine); Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

Module 3: Applications of Microbes in Biotransformations [9L]

Microbial based transformation of steroids and sterols; Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute.

Module 4: Microbial Products and their Recovery [6L]

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization

Module 5: Microbes for Bio-energy and Environment [10L]

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

Module 6: RNAi [3L]

RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

Module 7: [2L]

Intellectual Property Rights, Patents, Copyrights, Trademarks

Text / Reference Books:

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.

2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.

3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,

6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press

6. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

7. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science

8. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	2	-	1	-	-	-	-	-	-	2
CO2	3	1	2	1	-	-	-	-	-	-	-	2
CO3	3	2	2	1	1	-	-	2	-	-	-	-
CO4	1	-	2	-	-	-	-	-				2

Course Code	XMI5103			
Course Title	Microbial Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view at how microbes and their metabolic pathways and products can be utillised in biotechnology. The areas of particular concern such as Environmental biotechnology, bioremediation and biomining will also help to grow the interest of the students in the other aspects of biotechnology.

Course Outcome:

CO1: Able to understand an immobilized cell fermentor.

CO2: Able to understand the immobilization of enzymes in biocatalytic processes.

CO3: Able to isolate pigments from microorganisms.

CO4: Able to isolate xylanase or lipase producing bacteria.

CO5: Able to isolate single cell protein from algae.

Suggestive List of Experiments:

1. Study yeast cell immobilization in calcium alginate gels **[2days]**
2. Study enzyme immobilization by sodium alginate method **[2days]**
3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium) **[4days]**
4. Isolation of xylanase or lipase producing bacteria **[2days]**

5. Study of algal Single Cell Proteins **[2 day]**

Text / Reference Books:

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.

2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.

3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,

6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press

6. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

7. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science

8. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	2	-	1	-	-	-	-	-	-	2
CO2	3	1	2	1	-	-	-	-	-	-	-	2
CO3	3	2	2	1	1	-	-	2	-	-	-	-
CO4	1	-	2	-	-	-	-	-	-	-	-	2
CO5	-	2	2	-	2	-	-	-	1	-	-	-

Course Code	XMI5004			
Course Title	Advances In Microbiology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view at how microbes evolve their genomes and metagenomic approach in microbiology. This paper will also focus on virulence of pathogenic microbes, their interaction with the host system, their control by antimicrobial agents and networking in microbial world.

Course outcome:

CO1: Able to gain knowledge about how microbial genome evolves.

CO2: Able to get an idea about metagenomics and its application.

CO3: Able to know about the host-microbes interaction and also get to know about the mode of virulence of pathogenic microbes and their eradication by antibiotics.

CO4: Able to get an idea about synthetic biology and networking in biological system.

Course Content:

Module 1: Evolution of Microbial Genomes [9L]

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

Module 2: Metagenomics [10L]

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Module 3: Molecular Basis of Host-Microbe Interactions [14L]

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal

pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

Module 4: Systems and Synthetic Biology [15L]

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

Text / Reference Books:

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press

2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press

3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press

4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press

5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag

6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons

7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings

8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,

9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International

10. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	2	-	-	-	-	-	-	-	-	2
CO2	3	1	-	-	-	-	-	-	-	-	-	2
CO3	3	2	2	1	-	-	-	2	-	-	-	-
CO4	1	-	2	-	-	-	-	-	-	-	-	2

Course Code	XMI5104			
Course Title	Advances In Microbiology laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view at how metagenomic study can be used in the field of microbiology. The areas of particular concern are PCR technique, in vitro synthesis of viral genome and networking of different metabolic pathways in bacteria.

Course Outcome:

CO1: Able to understand the metagenomic approach employed in identifying unknown bacterial species from soil.

CO2: Able to understand the synthesis of polio virus genome in lab.

CO3: Able to understand networking of metabolic pathways in bacteria.

Suggestive List of Experiments:

1. Extraction of metagenomic DNA from soil **[3days]**

2. Understand the impediments in extracting metagenomic DNA from soil **[2days]**

3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers **[2day]**

4. Case study to understand how the poliovirus genome was synthesized in the laboratory **[2days]**

5. Case study to understand how networking of metabolic pathways in bacteria takes place **[3days]**

Text / Reference Books:

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press

2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press

3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press

4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press

5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag

6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons

7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings

8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,

9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International

10. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	2	1	-	-	-	-	-	-	-	2
CO2	3	2	-	2	-	-	-	-	-	-	-	2
CO3	3	-	2	1	-	-	-	2	-	-	-	-

Course Code	XMI5005			
Course Title	Inheritance Biology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth knowledge about gene interaction, penetrance and expressivity.

Course outcome:

CO1: Able to design, execute, and analyze the results of genetic experimentation in animal and plant model systems.

CO2: Able to acquire knowledge on hereditary disordres and epigenetic factors of different diseases based on genetic data

CO3: Able to gain Insight into the mathematical, statistical, and computational basis of genetic analyses that use genome-scale data sets in systems biology settings.

CO4: Able to recognize the experimental rationale of genetic studies

CO5: Able to understand the range of molecular laboratory techniques used routinely in human forensic analysis and population genetic analysis.

Course Content:

Module 1: Science of Genetics [2L]

An overview of modern history of Genetics before 1860, 1860-1900, 1900-1944, 1944-Present, about 3 general areas of Genetics (Classical, Molecular & Evolutionary).

Module 2: Mendelism & Chromosome Theory [7L]

Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal, Mitochondrial, Unifactorial, Multi-factorial).

Pedigree analysis – Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance.

Module 3: Extension of Mendelism **[5L]**

Deviation from Mendel's Dihybrid phenotype, Linkage, Sutton's view on linkage, Morgan's view on linkage, Bateson & Punnet's Coupling & Repulsion hypothesis.

Module 4: Linkage & Crossing over **[8L]**

Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Allelic Variation & Gene function – Multiple allele, Genetic interaction, Epiststic interactions, Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.

Module 5: Non-Mendelian inheritance **[8L]**

Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance.

Module 6: Chromosomal variation in Number & Structure **[8L]**

Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric & Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution.

Module 7: Chromosome Mapping **[5L]**

Haploid mapping (2 point & 3 point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.

Module 8: Human Cyto-Genetics **[5L]**

Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, Chromosomal abnormalities in spontaneous abortions, viable monosomies & trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions & translocations, human traits, Genomic position effects on Gene expression.

Text / Reference Books:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	2	3	-	2	-	-	-	-	-	-	2
CO2	3	-	2	-	-	-	-	-	-	-	-	3
CO3	-	2	2	2	-	-	-	-	-	-	-	2
CO4	-	-	-	-	2	-	-	-	-	-	1	-
CO5	-	-	-	2	2	-	-	-	-	-	-	3

Course Code	XMI5105			
Course Title	INHERITANCE BIOLOGY LAB			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to allow the students to deal with the various examples of Mendelian genetics and its deviations.

Course Outcome:

CO1: Able to gain knowledge required to design, execute, and analyze the results of genetic experimentation in animal and plant model systems.

CO2: Able to evaluate conclusions that are based on genetic data.

CO3: Able to get insight into the mathematical, statistical, and computational basis of genetic analyses.

Suggestive List of Experiments:

1. Permanent and temporary mount of mitosis. **[2days]**

2. Permanent and temporary mount of meiosis. **[2days]**

3. Mendelian deviations in dihybrid crosses. **[2days]**

4. Demonstration of - Barr Body -Rhoeo translocation. **[1days]**

5. Karyotyping with the help of photographs. **[1days]**

6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting. **[3days]**

7. Study of polyploidy in onion root tip by colchicine treatment. **[1days]**

Text / Reference Books:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	3	2	-	2	-	-	-	-	-	-	2
CO2	3	-	3	-	2	-	-	-	-	-	-	3
CO3	-	2	2	3	-	-	-	-	-	-	-	2

Detail Syllabus BSc Microbiology Semester-5

SEMESTER-6							
Sl. No.	**Type**	**Course No.**	**Course Name**	**L**	**T**	**P**	**Credits**
THEORY							
1	CORE	XMI6001	FOOD AND DAIRY MICROBIOLOGY	3	1	0	4
2	CORE	XMI6002	BIOSTATISTICS	3	1	0	4
3	DSE I		DISCIPLINE CENTRIC SUBJECTS III	3	1	0	4
4	DSE II		DISCIPLINE CENTRIC SUBJECTS IV	3	1	0	4
PRACTICAL							
5	CORE	XMI6101	FOOD AND DAIRY MICROBIOLOGY LAB	0	0	3	2
6	CORE	XMI6102	BIOSTATISTICS LAB	0	0	3	2
7	DSE I		DISCIPLINE CENTRIC SUBJECTS III LAB	0	0	3	2
8	DSE II		DISCIPLINE CENTRIC SUBJECTS IV LAB	0	0	3	2
TOTAL				**12**	**4**	**12**	**24**

Course Code	XMI6001			
Course Title	Food And Dairy Microbiology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Food and Dairy Microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: Understand the role of microorganisms in food fermentation, food processing, food spoilage and food borne diseases

CO2: Understand the significance of microbes in spoilage of different varieties of food and the role of intrinsic and extrinsic factors affecting the growth and survival of microbes in food.

CO3: Describe ways to control the growth of microbes in foods and know the principals involved in methods of food preservation.

CO4: Understand the beneficial role of microbes in fermented foods and the microbiology of fermented dairy products and other indigenous fermented foods and understand the basis of food safety regulations

Course Content:

Module 1: Foods as a substrate for microorganisms [6L]

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

Module 2: Microbial spoilage of various foods [7L]

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

Module 3: Principles and methods of food preservation [7L]

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, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Module 4: Fermented foods **[7L]**

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

Module 5: Food borne diseases **[7L]**

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

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;

Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Module 6: Food sanitation and control **[7L]**

HACCP, Indices of food sanitary quality and sanitizers

Module 7: Detection **[7L]**

Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology

Text / 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. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.

9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI6101			
Course Title	Food And Dairy Microbiology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Food and Dairy Microbiology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of microbiology.

Course Outcome:

CO1: To understand concepts in milk microbiology.

CO2: To complement the students with the basic knowledge of food microbiology.

CO3: To acquaint the students with food preservation techniques.

CO4: To know the concepts related to popular milk products, milk examination and spoilage.

Suggestive List of Experiments:

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

Text / 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. CAB International, Wallingford, Oxon.

5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	-	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI6002			
Course Title	Biostatistics			
Category	Microbiology			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biostatistics and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biostatistics.

Course Outcome:

CO1: Student will understand about biostatistics

CO2: To understand about collection and calculation measures of central tendency

CO3: Student will understand various statistical methods

CO4: Student will understand various basics of calculus

Course Content:

Module 1: Biomathematics [24L]

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

Module 2: Biostatistics [24L]

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.

Text / 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.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	1	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI6102			
Course Title	Biostatistics Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of Biostatistics and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biostatistics.

Course Outcome:

CO1: Assess critically the Word Problems based on Differential Equations

CO2: Critically assess research methods involving statistical techniques.

CO3: An understanding of the statistical models and analyses that can be applied to different kinds of biological data.

CO4: Understand the process of different testing hypothesis with microbiological samples.

Suggestive List of Experiments:

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

Text / 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.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	1	1	2	1	-	-	2	1	1	-	1	-
CO3	-	2	2	1	1	1	-	-	-	-	-	-
CO4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XMI6003			
Course Title	Microbes In Sustainable Agriculture And Development			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view at how microbial activity in soil helps in the improvement of soil quality and their role as bio control agents for plant pathogens.

Course outcome:

CO1: Able to acquire a fairly good understanding of microbes in the soil.

CO2: Able to gain knowledge about the of the use of microbes in sustainable agriculture namely role in biogeochemical recycling, nitrogen fixing, organic matter degradation, use as bio fertilizers, as bio pesticides, production of biofuels

CO3: Able to develop skills for growing microorganisms in the laboratory for the production of different enzymes by different microorganisms.

Course Content:

Module 1: Soil Microbiology [9L]

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

Module 2: Mineralization of Organic & Inorganic Matter in Soil [9L]

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Module 3: [9L]

Microbial Activity in Soil and Green House Gases, Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Module 4: [6L]

Microbial Control of Soil Borne Plant Pathogens, Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Module 5: [10L]

Biofertilization, Phytostimulation, Bioinsecticides, Plant growth promoting bateria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Module 6: [3L]

Secondary Agriculture Biotechnology, Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Module 7: [2L]

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

Text / 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, ASM Press,

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

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

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

7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.

10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.

11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.

12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	2	-	1	-	-	-	-	-	-	2
CO2	2	-	2	-	-	2	-	1	1	-	-	-
CO3	-	2	2	2	-	1	-	-	1	-	-	-

Course Code	XMI6103			
Course Title	Microbes In Sustainable Agriculture And Development Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to allow the students an in-hand experience of using microorganisms in soil to improve the soil profile and an in-depth idea to construct a biogas plant.

Course Outcome:

CO1: Able to understand the various criteria of soil and use of different bacteria to improve the soil profile.

CO2: Able to understand the design and functioning of a biogas plant

CO3: Able to understand how to isolate a cellulose degrading organism from soil.

Suggestive List of Experiments:

1. Study soil profile. **[2days]**
2. Study microflora of different types of soils. **[2days]**
3. Rhizobium as soil inoculants characteristics and field application **[2days]**
4. Azotobacter as soil inoculants characteristics and field application **[2days]**
5. Design and functioning of a biogas plant **[2days]**
6. Isolation of cellulose degrading organisms **[2days]**

Text / 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, ASM Press,

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

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

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

7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.

10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.

11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.

12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	3	2	2	-	1	-	-	-	-	-	2
CO2	2	-	2	-	-	2	-	-	1	-	-	-
CO3	2	2	2	1	-	1	-	-	1	-	-	-

Course Code	XMI6004			
Course Title	Plant Pathology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view at how microbes can cause harm in plant, the response of plant to the infecting microbes and also the methods of pathogen eradication.

Course outcome:

CO1: Able to develop basic concepts of causation of diseases in plants by the different types of microorganisms namely bacterial, fungal and viral.

CO2: Able to gain knowledge of important plant diseases, their etiology, salient characteristics and control measures

CO3: Able to develop skills to analyze the diseased plant samples in the laboratory and are able to identify the salient features of the disease-causing microbe and the lesions produced on the plant parts.

Course Content:

Module 1: Introduction and History of plant pathology [5L]

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.

Module 2: Stages in development of a disease [3L]

Infection, invasion, colonization, dissemination of pathogens and perennation.

Module 3: Plant disease epidemiology [5L]

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Module 4: Host Pathogen Interaction [15L]

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).

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.

Defense Mechanisms in Plants

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological- cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Module 5: Control of Plant Diseases [10L]

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

Module 6: Specific Plant diseases [10L]

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

Important diseases caused by fungi White rust of crucifers - Albugo candida

Downy mildew of onion - Peronospora destructor Late blight of potato - Phytophthora infestans Powdery mildew of wheat - Erysiphe graminis Ergot of rye - Claviceps purpurea

Black stem rust of wheat - Puccinia graminis tritici

Loose smut of wheat - Ustilago nuda

Wilt of tomato - Fusarium oxysporum f.sp. lycopersici

Red rot of sugarcane - Colletotrichum falcatum

Early blight of potato - Alternaria solani

Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn

Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

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

Text / 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.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	2	-	-	-	-	-	2	-	-	2
CO2	2	-	2	-	-	2	-	-	1	-	-	2
CO3	-	2	2	1	-	1	-	-	1	-	1	-

Course Code	XMI6104			
Course Title	Plant Pathology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to allow the students hands on experience of the demonstration of Koch's postulate and important plant diseases.

Course Outcome:

CO1: Able to understand the Koch's postulates applicability in various plant pathogens.

CO2: Able to understand the nature of different important diseases in plant.

Suggestive List of Experiments:

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens. **[6days]**

2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum*. **[6days]**

Text / 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.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	2	-	-	-	-	-	2	-	-	2
CO2	2	-	2	-	-	2	-	-	1	-	-	2

Course Code	XMI6005			
Course Title	Biosafety And Intellectual Property Rights			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to introduce the students an in-depth view about various aspects of biosafety regulations, Intellectual Property Right and bioethic concerns arising from the commercialization of biotech products.

Course outcome:

CO1: Full knowledge of working in a microbiology laboratory taking all safety measures, handing of live bacteria, disposal of infectious waste, care of the equipment requiring safety audit

CO2: Able to gain knowledge Developed knowledge of basic concepts related to IPR.

CO3: Able to develop knowledge of patent filing, and some well-known/well-publicized case studies related to IPR.

Course Content:

Module 1: Biosafety **[9L]**

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

Module 2: Biosafety Guidelines **[9L]**

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

Module 3: **[6L]**

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

Module 4: Introduction to Intellectual Property **[9L]**

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

Module 5: Grant of Patent and Patenting Authorities **[10L]**

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

Module 6: Agreements and Treaties **[5L]**

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

Text / Reference Books:

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.

2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.

3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.

4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.

5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	-	-	-	-	-	-	-	2
CO2	2	-	2	-	-	2	-	-	1	-	-	2

CO3	2	-	2	-	-	-	-	1	-	-	1	-

Course Code	XMI6105			
Course Title	Biosafety And Intellectual Property Rights Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objective:

The main aim of this paper is to provide the students hands on experience of the components and design of different biosafety level laboratory and how to approach for a patent right.

Course Outcome:

CO1: Able to construct a BSL-III laboratory.

CO2: Able to file application to a biodsafety commitee.

CO3: Able to file patent for a biological sample.

Suggestive List of Experiments:

1. Study of components and design of a BSL-III laboratory **[2days]**
2. Filing applications for approval from biosafety committee **[2days]**
3. Filing primary applications for patents **[5days]**
4. Study of steps of a patenting process **[3days]**

Text / Reference Books:

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.

2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.

3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.

4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.

5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	-	-	-	-	-	-	-	2
CO2	2	-	2	-	-	2	-	-	1	-	-	2
CO3	2	-	2	-	-	-	-	1	-	-	1	-