CHOICE BASED CREDIT SYSTEM

Scheme of Instruction & Syllabus for

B.Sc. BIOTECHNOLOGY

2021-2022

JIS UNIVERSITY

B.Sc. (Hons.) Biotechnology

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	$14X4 = 56$	$14 \times 2 = 28$	56+28=**84**
DSE	4	$4X4 = 16$	$4 \times 2 = 08$	16+08=**24**
GE	4	4X4=16	4X2=8	16+08=**24**
SEC	2	2x2=4		**04**
AECC	4	4x2=8		**08**
TOTAL				**144**
NON-CGPA				
SEMINAR/MOOKS/OTHER ACTIVITIES	6		1	06
SKILLX/NSS	6		1	06
			Grand Total Credit	**156**

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	**Semester**

(14 Papers for the Students of Biotechnology)		
CORE I	BIOCHEMISTRY & METABOLISM	**I**
CORE II	CELL BIOLOGY	
CORE III	MAMMALIAN PHYSIOLOGY	**II**
CORE IV	PLANT PHYSIOLOGY	
CORE V	GENETICS	**III**
CORE VI	MOLECULAR BIOLOGY	
CORE VII	CHEMISTRY I	
CORE VIII	IMMUNOLOGY	**IV**
CORE IX	BIOINFORMATICS	
CORE X	CHEMISTRY 2	
CORE XI	BIOPROCESS TECHNOLOGY	**V**
CORE XII	RECOMBINANT DNA TECHNOLOGY	
CORE XIII	BIOSTATISTICS	**VI**
CORE XIV	GENOMICS AND PROTEOMICS	

Choices for DSE

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

DSE_1	Animal Biotechnology	XBT5003
DSE_2	Medical Biotechnology	XBT5004
DSE_3	Ecology And Environmental Management	XBT5005
DSE _4	Environmental Biotechnology	XBT5006
DSE_5	Industrial Biotechnology	XBT6003
DSE_6	Plant Biotechnology	XBT6004
DSE_7	Food Biotechnology	XBT6005
DSE_8	Virology	XBT6006

Choices for SEC

(Any one per semester in semesters 3-4)

SEC_1	Biofertilizers and Biopesticides	XBT3004
SEC_2	Enzymology	XBT3005
SEC_3	Industrial Fermentations	XBT3006
SEC_4	Drug Designing	XBT4004

SEC_5	Basics of Forensic Biology	XBT4005
SEC_6	Molecular Diagnostics	XBT4006

Choices for AECC (Any one per semester in semesters 3-4)	
AECC_1	English
AECC_2	Environmental Science
AECC_3	Entrepreneurship Development
AECC_4	Values and Ethics

SEMESTER-1									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
Theory									
1	CORE	XBT1001	Biochemistry & Metabolism	3	1	0	4	4	100
2	CORE	XBT1002	Cell Biology	3	1	0	4	4	100
3	GE I		General Elective	3	1	0	4	4	100
4	AECC I	XED1001	English	2	0	0	2	2	50
Practical									
5	CORE	XBT1101	Biochemistry & Metabolism Lab	0	0	3	2	3	50
6	CORE	XBT1102	Cell Biology Lab	0	0	3	2	3	50
7	GE I		General Elective Lab	0	0	3	2	3	50
	TOTAL			**11**	**3**	**9**	**20**	**23**	**500**

SEMESTER-2									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT2001	Mammalian Physiology	3	1	0	4	4	100
2	CORE	XBT2002	Plant Physiology	3	1	0	4	4	100
3	GE II		General Elective	3	1	0	4	4	100
4	AECC II	XBT2003	Environmental Science	2	0	0	2	2	50
Practical									
5	CORE	XBT2101	Mammalian Physiology Lab	0	0	3	2	3	50
6	CORE	XBT2102	Plant Physiology Lab	0	0	3	2	3	50
7	GE II		General Elective Lab	0	0	3	2	3	50
	TOTAL			**11**	**3**	**9**	**20**	**23**	**500**

SEMESTER-3									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT3001	Genetics	3	1	0	4	4	100
2	CORE	XBT3002	Molecular Biology	3	1	0	4	4	100
3	CORE	XBT3003	Chemistry I	3	1	0	4	4	100
4	GE III		General Elective	3	1	0	4	4	100
5	SEC I		Skill Enhance Courses I	2	0	0	2	2	50
6	AECC III	XBB3009	Entrepreneurship Development	2	0	0	2	2	50
Practical									
7	CORE	XBT3101	Genetics Lab	0	0	3	2	3	50
8	CORE	XBT3102	Molecular Biology Lab	0	0	3	2	3	50
9	CORE	XBT3103	Chemistry I Lab	0	0	3	2	3	50
10	GE III		General Elective Lab	0	0	3	2	3	50
	TOTAL			**16**	**4**	**12**	**28**	**32**	**700**

SEMESTER-4									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT4001	Bioinformatics	3	1	0	4	4	100
2	CORE	XBT4002	Immunology	3	1	0	4	4	100
3	CORE	XBT4003	Chemistry II	3	1	0	4	4	100
4	GE IV		General Elective	3	1	0	4	4	100
5	SEC II		Skill Enhance Courses II	2	0	0	2	2	50
6	AECC IV		Values And Ethics	2	0	0	2	2	50
Practical									
7	CORE	XBT4101	Bioinformatics Lab	0	0	3	2	3	50
8	CORE	XBT4102	Immunology Lab	0	0	3	2	3	50
9	CORE	XBT4103	Chemistry Ii Lab	0	0	3	2	3	50
10	GE IV		General Elective Iv Lab	0	0	3	2	3	50
	TOTAL			**16**	**4**	**12**	**28**	**32**	**700**

SEMESTER-5									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT5001	Bioprocess Technology	3	1	0	4	4	100
2	CORE	XBT5002	Recombinant Dna Technology	3	1	0	4	4	100
3	DSE I		Discipline Centric Subjects I	3	1	0	4	4	100
4	DSE II		Discipline Centric Subjects II	3	1	0	4	4	100
PRACTICAL									
5	CORE	XBT5101	Bioprocess Technology Lab	0	0	3	2	3	50
6	CORE	XBT5102	Recombinant Dna Technology Lab	0	0	3	2	3	50
7	DSE I		Discipline Centric Subjects I Lab	0	0	3	2	3	50
8	DSE II		Discipline Centric Subjects II Lab	0	0	3	2	3	50
	TOTAL			**12**	**4**	**12**	**24**	**28**	**600**

SEMESTER-6									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT6001	Biostatistics	3	1	0	4	4	100
2	CORE	XBT6002	Genomics And Proteomics	3	1	0	4	4	100
3	DSE I		Discipline Centric Subjects III	3	1	0	4	4	100
4	DSE II		Discipline Centric Subjects IV	3	1	0	4	4	100
PRACTICAL									
5	CORE	XBT6101	Biostatistics Lab	0	0	3	2	3	50
6	CORE	XBT6102	Genomics And Proteomics Lab	0	0	3	2	3	50
7	DSE I		Discipline Centric Subjects III Lab	0	0	3	2	3	50
8	DSE II		Discipline Centric Subjects IV Lab	0	0	3	2	3	50
	TOTAL			**12**	**4**	**12**	**24**	**28**	**600**

Detail Syllabus B.Sc. Biotechnology Semester-1

SEMESTER-1									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT1001	BIOCHEMISTRY & METABOLISM	3	1	0	4	4	100
2	CORE	XBT1002	CELL BIOLOGY	3	1	0	4	4	100
3	GE I		GENERAL ELECTIVE I	3	1	0	4	4	100
4	AECC I	XED1001	ENGLISH	2	0	0	2	2	50
PRACTICAL									
5	CORE	XBT1101	BIOCHEMISTRY & METABOLISM LAB	0	0	3	2	3	50
6	CORE	XBT1102	CELL BIOLOGY LAB	0	0	3	2	3	50
7	GE I		GENERAL ELECTIVE I LAB	0	0	3	2	3	50
	TOTAL			**11**	**3**	**9**	**20**	**23**	**500**

Course Code	XBT1001			
Course Title	Biochemistry 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 Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of biochemistry and metabolism.

Course Outcome:

CO1: Able to understand the function of biological molecules through the study of their molecular structure, and interaction with other biomolecules.

CO2: Able to develop an 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: Able to demonstrate an awareness of the impact of biochemistry on the environment, society, and other cultures outside the scientific community.

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

Course Content:

Module 1: Introduction to Biochemistry [12L]

A historical prospective.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

Module 2: [12L]

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

Module 3: **[14L]**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

Module 4: **[10L]**

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle. Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Text / Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co.

CO-PO Mapping:

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

Course Code	XBT1101

Course Title	BIOCHEMISTRY AND METABOLISM LAB			
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

Course Outcome:

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

CO2: Ability to perform basic laboratory procedures used in small molecule analysis, organic syntheses, and the protein and nucleic acids biochemistry laboratory, including good standard lab practices and accurate record keeping.

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

CO4: Able to design effective experiments and critically analyze data.

Suggestive List of Experiments:

1. To study activity of any enzyme under optimum conditions. **[1 day]**

2. To study the effect of pH, temperature on the activity of salivary amylase enzyme. **[1 day]**

3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity. **[2 days]**

4. Estimation of blood glucose by glucose oxidase method. **[1 day]**

5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission. **[1 day]**

6. Preparation of buffers. **[1 day]**

7. Separation of Amino acids by paper chromatography. **[1 day]**

8. Qualitative tests for Carbohydrates, lipids and proteins **[3 days]**

Text / Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co.

CO-PO Mapping:

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

Course Code	XBT1002			
Course Title	Cell Biology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

The objective of this course is to demonstrate significant cell biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology to be translated into practical understanding.

Course outcome:

CO1: Able to understand of the structure of cell and various cellular events and function of various subcellular organelles

CO2: Able to describe cell theory and techniques for fractionation of sub-cellular organelles.

CO3: Able to acquire various microscopic techniques to visualize subcellular organelles.

CO4: Able to understand the composition of cytoskeleton and extracellular matrix.

CO5: Able to acquire knowledge of cell cycle, cell division and cell death mechanisms.

Course Content:

Module 1 **[12L]**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

Module 2 **[12L]**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

Module 3 **[12L]**

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

Module 4 **[12L]**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

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. ASMPress & 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
CO2	2	1	1	-	-	-	-	-	-	-	-	2
CO3	1	-	-	2	2	-	-	-	-	-	-	2
CO4	3	-	1	-	2	-	-	-	-	-	-	-
CO5	3	-	1	-	-	-	-	-	-	-	-	2

Course Code	XBT1102			
Course Title	Cell Biology Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The objective of this course is to demonstrate significant cell biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology to be translated into practical understanding.

Course outcome:

CO1: Students will be able to differentiate the cells of various living organisms

CO2: Awareness of physiological processes of cell e.g., cell divisions.

CO3: Students will be able to observe and correctly identify different cell types, cellular structures

Suggestive List of Experiments:

1. Study the effect of temperature and organic solvents on semi permeable membrane. **[2 days]**

2. Demonstration of dialysis. **[2 days]**

3. Study of plasmolysis and de-plasmolysis. **[1 day]**

4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source. **[2 days]**

5. Study of structure of any Prokaryotic and Eukaryotic cell. **[1 day]**

6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes. **[2 days]**

7. Cell division in onion root tip/ insect gonads. **[1 day]**

8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions. **[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. ASMPress & 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
CO2	-	-	3	1	-	-	-	-	-	-	-	2
CO3	2	-	2	2	-	-	-	-	-	-	-	2

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: Interface in a Globalized World [4L]

a. Definition of Communication; Scope of Communication

b. Process of Communication—Models and Types

c. Verbal—Non-Verbal Communication, Channels of Communication

d. Barriers to Communication & surmounting them [to be delivered through case studies involving intercultural communication]

Module 2: Vocabulary and Reading [6L]

a. Word origin—Roots, Prefixes and Suffixes, Word Families, Homonyms and Homophones

b. Antonyms and Synonyms, One-word substitution

c. Reading—Purposes and Skills

d. Reading Sub-Skills—Skimming, Scanning, Intensive Reading

e. Comprehension Practice (Fiction and Non fictional Prose/Poetry)

Texts:

(i) Isaac Asimov, I Robot ("Robbie" OR "Little Lost Robot")

(ii) George Orwell, "Shooting an Elephant"

(iii) Ruskin Bond, "The Cherry Tree" OR "The Night Train at Deoli"

(iv) Robert Frost, "Stopping by the Woods on a Snowy Evening."

f. Precis Writing (Use of daily newspapers for reading practice is recommended)

Module 3: Functional Grammar and Usage **[8L]**

a. Articles, Prepositions, Verbs

b. Verb-Subject Agreement

c. Comparison of Adjectives

d. Tenses and their Use

e. Transformation of Sentences (Singular-Plural, Active-Passive, Direct-Indirect, Degrees of Comparison)

f. Error Correction

Module 4: Business writing **[6L]**

a. Business Communication in the Present-day scenario

b. Business Letters (Letters of Inquiry, Sales Letters, Complaint and Adjustment Letters, Job Application Letters)

c. Drafting of a CV and Résumé

d. Memo, Notice, Advertisement, Agenda, Minutes of Meetings

e. E-mails (format, types, jargons, conventions)

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. Biotechnology Semester-2

SEMESTER-2									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT2001	MAMMALIAN PHYSIOLOGY	3	1	0	4	4	100
2	CORE	XBT2002	PLANT PHYSIOLOGY	3	1	0	4	4	100
3	GE II		GENERAL ELECTIVE II	3	1	0	4	4	100
4	AECC II	XBT2003	ENVIRONMENTAL SCIENCE	2	0	0	2	2	50
PRACTICAL									
5	CORE	XBT2101	MAMMALIAN PHYSIOLOGY LAB	0	0	3	2	3	50
6	CORE	XBT2102	PLANT PHYSIOLOGY LAB	0	0	3	2	3	50
7	GE II		GENERAL ELECTIVE II LAB	0	0	3	2	3	50
	TOTAL			**11**	**3**	**9**	**20**	**23**	**500**

Course Code	XBT2001			
Course Title	Mammalian Physiology			
Category	Core Course			
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 to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

Course Outcome:

CO1: Able to explain human anatomy and physiology, cellular levels of organization, and the basics of biochemistry and cell biology.

CO2: Able to explore the skin and examine the body's skeletal and muscular systems, following a traditional sequence of topics.

CO3: Able to discuss system physiology and system control and regulation.

CO4: Able to discover the interaction between body systems and the outside environment for the exchange of materials, the release of waste, and the overall maintenance of the internal systems that regulate the exchange.

Course Content:

Module 1: Digestion and Respiration [12L]

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

Module 2: Circulation [12L]

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood.

Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

Module 3: Muscle Physiology and Osmoregulation [12L]

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

Module 4: Nervous and Endocrine Coordination [12L]

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Text / Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

CO-PO Mapping:

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

Course Code	XBT2101			
Course Title	Mammalian Physiology 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 to the physiology of animal systems with special emphasis on humans, thereby allowing them to understand how animal systems function

Course outcome:

CO1: Will be able to draw blood, identify blood cells.

CO2: Will be able to determine blood group of an individual.

CO3: Ability to demonstrate the action of enzyme

Suggestive List of Experiments:

1. Finding the coagulation time of blood **[1 day]**
2. Determination of blood groups **[1 day]**
3. Counting of mammalian RBCs **[1 day]**
4. Determination of TLC and DLC **[1 day]**
5. Demonstration of action of an enzyme **[1 day]**
6. Determination of Haemoglobin **[1 day]**

Text / Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons,Inc.

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	-	-	-	-	-	-	-	2
CO3	1	-	2	-	-	-	-	-	-	-	-	2

Course Code	XBT2002			
Course Title	Plant Physiology			
Category	Core Course			
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 to the physiology of plant systems, thereby allowing them to understand how plant systems function

Course outcome:

CO1: Able to understand and appreciate the plant world we depend on.

CO2: Able to gain knowledge about the basic principles of plant function, metabolism, secondary products, cell physiology & principles of growth & development.

CO3: Able to discuss plant physiology and growth and metabolic regulation in plant

CO4: Able to describe the minimal requirements for plant growth and development

Course Content:

Module 1: Anatomy [9L]

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

Module 2: Plant Water Relations and Micro & Macro Nutrients [9L]

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

Module 3: Carbon and Nitrogen Metabolism [15L]

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Module 4: Growth and Development [15L]

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

Text / Reference Books:

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.

2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.

3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.

4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.

5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.

6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.

7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

CO-PO Mapping:

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

Course Code	XBT2102			
Course Title	Plant Physiology 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 introduce the students to the physiology of plant systems, thereby allowing them to understand how plant systems function

Course Outcome:

CO1: Able to understand anatomy of monocot and dicot's root, stem & leaf

CO2: Able to understand the basics of plasmolysis and aerobic respiration.

CO3: Able to isolate photosynthetic pigments.

Suggestive List of Experiments:

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf. **[2 days]**
2. Demonstration of plasmolysis by Tradescantia leaf peel. **[1 day]**
3. Demonstration of opening & closing of stomata **[1 day]**
4. Demonstration of guttation on leaf tips of grass and garden nasturtium. **[1 day]**
5. Separation of photosynthetic pigments by paper chromatography. **[1 day]**
6. Demonstration of aerobic respiration. **[1 day]**
7. Preparation of root nodules from a leguminous plant. **[1 day]**

Text / Reference Books:

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

CO-PO Mapping:

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

Course Code	XCH2004			
Course Title	Chemistry of Microbial Life			
Category	GE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

This course deals with characteristics, properties and biological significance of the biomolecules of microbial life. In depth knowledge of the energetic and regulation of different metabolic processes in microorganisms.

Course outcome:

CO1: Able to understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes.

CO2: Able to understand the structural similarities and differences among various physiological groups of bacteria

CO3: Able to gain knowledge of various Culture media, aseptic techniques and their applications and also understand various physical and chemical means of sterilization.

CO4: Able to comprehend the various methods for identification of unknown microorganisms

Course content:

Module 1: **[16L]**

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Module 2: **[12L]**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

Module 3: **[12L]**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

Module 4: **[8L]**

Control of Microorganisms: By physical, chemical and chemotherapeutic agents.

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 Microbiology. 5th edition. McMillan.

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

4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

CO-PO Mapping:

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

Course Code	XCH2104			
Course Title	Chemistry of Microbial Life Laboratory			
Category	GE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The course aims to provide details understanding and hand on training on techniques used in microbiology.

Course outcome:

CO1: Able to identify microorganisms

CO2: Able to characterize microorganisms

CO3: Able to isolate microorganisms from different sources

Suggestive list of experiments:

1. Isolation of bacteria & their biochemical characterization. **[2 days]**

2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. **[5 days]**

3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources. **[3 days]**

4. Determination of bacterial cell size by micrometry. **[1 day]**

5. Enumeration of microorganism - total & viable count. **[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 Microbiology. 5th edition. McMillan.

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

4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

CO-PO Mapping:

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

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 B.Sc. Biotechnology Semester-3

SEMESTER-3									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT3001	GENETICS	3	1	0	4	4	100
2	CORE	XBT3002	MOLECULAR BIOLOGY	3	1	0	4	4	100
3	CORE	XBT3003	CHEMISTRY I	3	1	0	4	4	100
4	GE III		GENERAL ELECTIVE III	3	1	0	4	4	100
5	SEC I		SKILL ENHANCE COURSES I	2	0	0	2	2	50
6	AECC III	XBB3009	ENTREPRENEURSHIP DEVELOPMENT	2	0	0	2	2	50
PRACTICAL									
7	CORE	XBT3101	GENETICS LAB	0	0	3	2	3	50
8	CORE	XBT3102	MOLECULAR BIOLOGY LAB	0	0	3	2	3	50
9	CORE	XBT3103	CHEMISTRY I LAB	0	0	3	2	3	50
10	GE III		GENERAL ELECTIVE III LAB	0	0	3	2	3	50
	TOTAL			**16**	**4**	**12**	**28**	**32**	**700**

Course Code	XBT3001			
Course Title	Genetics			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

The course will allow to understand the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders.

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: **[10L]**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

Module 2: **[12L]**

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

Module 3: **[12L]**

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

Module 4: **[14L]**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

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	XBT3101			
Course Title	Genetics Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The course will allow to understand the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders.

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. **[1 day]**

2. Permanent and temporary mount of meiosis. **[1 day]**

3. Mendelian deviations in dihybrid crosses **[1 day]**

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

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

6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting. **[1 day]**

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

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

Course Code	XBT3002			
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 objectives:

This course provides insight on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms, regulation of gene expression and mechanism of gene transfer.

Course Outcome:

CO1: Able to acquire in-depth knowledge on how cellular machinery works, especially the proteins factors orchestrating the processes.

CO2: Able to present hypotheses and select, adapt and conduct molecular and cell-based experiments to either confirm or reject the hypotheses.

CO3: Able to 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: DNA Structure and Replication [8L]

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

Module 2: DNA Damage, Repair and Homologous Recombination [10L]

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

Module 3: Transcription and RNA Processing [15L]

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains

Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Module 4: Regulation of Gene Expression and Translation [15L]

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins.

Text / Reference Books:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

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	-	-	2	-	-	-	-	-	-	3
CO3	-	-	2	-	3	-	-	-	1	-	-	2

Course Code	XBT3102			
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 objectives:

This course provides insight on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms, regulation of gene expression and mechanism of gene transfer.

Course Outcome:

CO1: Able to independently execute a laboratory experiment using the standard methods and techniques in molecular biology, with the appropriate analysis and interpretation of results obtained.

CO2: Able to equip with molecular tools to enable their laboratory skills and troubleshooting mechanisms to become a competent molecular biologist.

CO3: Able to correlate theoretical aspects of molecular phenomena to finding practical basis of life and its maintenance.

Suggestive List of Experiments:

1. Preparation of solutions for Molecular Biology experiments. **[1 day]**
2. Isolation of chromosomal DNA from bacterial cells. **[1 day]**
3. Isolation of Plasmid DNA by alkaline lysis method **[2 days]**
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA **[1 day]**
5. Preparation of restriction enzyme digests of DNA samples **[2 days]**
6. Demonstration of AMES test or reverse mutation for carcinogenicity **[1 day]**

Text / Reference Books:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

CO-PO Mapping:

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

Course Code	XBT3003			
Course Title	Chemistry I			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	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 atomic structure, chemical bonding and fundamentals of organic chemistry.

Course Outcome:

CO1: To understand the quantum mechanical interpretation of atomic structure

CO2: Classify the inorganic compounds in terms of bonding and will be able to predict the geometry of the molecule

CO3: Determine the number of unpaired electron present in a molecule/ion and thereby able to evaluate magnetic properties of the molecule/ions

CO4: Understand about reaction intermediates, their stability and mode of activity

CO5: Predict the stereochemistry of a compound with respect to isomerism, conformation, and their nomenclature

CO6: Identify the major product and mechanistic pathway of the reactions of aliphatic hydrocarbons alkanes, alkenes and alkyne

Course Content:

Section A: Inorganic Chemistry-1

Module 1: Atomic Structure **[12L]**

Review of: Bohr's theory and its limitations, dual behavior of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d

atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Module 2: Chemical Bonding and Molecular Structure [12L]

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

Section B: Organic Chemistry-1

Module 1: Fundamentals of Organic Chemistry [8L]

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Module 2: Stereochemistry [6L]

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). 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: Aliphatic Hydrocarbons [10L]

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkline $KMnO_4$.

Text / Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:
5. Principles of Structure and Reactivity, Pearson Education India, 2006.
6. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
7. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
8. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

CO-PO Mapping:

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

Course Code	XBT3103			
Course Title	Chemistry I Laboratory			
Category	CORE COURSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
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 as well as ions volumetrically

CO2: To measure the Rf value of a particular compound

CO3: To identify and separate the components of a given mixture of two amino acids/ sugars

Suggestive List of Experiments:

Section A: Inorganic Chemistry - Volumetric Analysis (any two/three)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. **[1 day]**

2. Estimation of oxalic acid by titrating it with KMnO4. **[1 day]**

3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4. **[1 day]**

4. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator. **[1 day]**

5. Estimation of Cu (II) ions iodometrically using Na2S2O3. **[1 day]**

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements) **[6 days]**

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

[2 days]

(b) Identify and separate the sugars present in the given mixture by paper chromatography

[1 day]

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 Organic Chemistry, Prentice-Hall, 5th edition, 1996.

4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

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	-	2	-	-	-	-	-	-	2
CO3	3	2	2	3	2	-	-	-	-	-	-	1

Course Code	XBT3004			
Course Title	Biofertilizers And Biopesticide			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

The course aims to provide detail understanding of biopesticides and biocontrol agents. It will highlight on how microorganisms can be used to maintains soil health.

Course outcome:

CO1: Able to acquaint with the importance of bio-pesticides in present scenario.

CO2: Able to understand concept and classification of biocontrol strategies

CO3: Able to understand role of bio-fertilizers in quality parameters of various agricultural products and key role of bio-fertilizer in maintain soil health.

CO4: Able to understand bioethical issues of releasing GMOs

Course Content:

Module 1: Biofertilizers [6L]

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 [4L]

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

Module 3: Phosphate Solubilizers [4L]

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

Module 4: Mycorrhizal Biofertilizers [4L]

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

Module 5: Bioinsecticides [6L]

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

Course Code	XBT3005			
Course Title	Enzymology			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

This course will provide a view of enzyme chemistry and kinetics along with the methods and strategies for enzyme purification and characterization. One section also deals with the applications of enzymes in diagnostics.

Course outcome:

CO1: Able to distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms

CO2: Able to discuss the factors affecting enzymatic reactions. Describe the concepts of co-operative behaviour, enzyme inhibition and allosteric regulation.

CO3: Able to describe the major applications of enzymes in industry, understand the principles of enzyme immobilisation techniques and enzyme extraction procedures.

CO4: Able to develop new ideas for the development of enzyme-based drugs. Discuss various application of enzymes that can benefit human life

CO5: Able to discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.

Course Content:

Module 1: **[8L]**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

Module 2: **[4L]**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques

for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

Module 3: **[4L]**

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

Module 4: **[8L]**

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes. Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding invitro & invivo.

Text / Reference Books:

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.

2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.

3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.

4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning, 2005.

5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999

6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004

7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004

8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

CO-PO Mapping:

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

Course Code	XBT3006			
Course Title	Industrial Fermentations			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

The course aims to provide the understanding of basic principle of fermentation process, which help students to design, develop and operate fermentation process at industrial level. This fundamental knowledge is essential for the students to make their career in industry based on bioprocess.

Course outcome:

CO1: Able to understand the basic concepts of industrial microbiology.

CO2: Able to recognize products of industrial microbiology and efficient modification in fermenter design.

CO3: Able to be familiarize with the processes oriented in industry and R&D settings.

CO4: Able to understand the production cycles of various microbial products at lab scale and how to carry it to industrial range.

Course Content:

Module 1: **[4L]**

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

Module 2: **[6L]**

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

Module 3: **[6L]**

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation

broth, ultra-centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Module 4: **[8L]**

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Text / Reference Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

5. Salisbury, Whitaker and Hall. Principles of fermentation Technology,

CO-PO Mapping:

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

Course Code				
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				
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	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 B.Sc. Biotechnology Semester-4

SEMESTER-4									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT4001	BIOINFORMATICS	3	1	0	4	4	100
2	CORE	XBT4002	IMMUNOLOGY	3	1	0	4	4	100
3	CORE	XBT4003	CHEMISTRY II	3	1	0	4	4	100
4	GE IV		GENERAL ELECTIVE IV	3	1	0	4	4	100
5	SEC II		SKILL ENHANCE COURSES II	2	0	0	2	2	50
6	AECC IV		VALUES AND ETHICS	2	0	0	2	2	50
PRACTICAL									
7	CORE	XBT4101	BIOINFORMATICS LAB	0	0	3	2	3	50
8	CORE	XBT4102	IMMUNOLOGY LAB	0	0	3	2	3	50
9	CORE	XBT4103	CHEMISTRY II LAB	0	0	3	2	3	50
10	GE IV		GENERAL ELECTIVE IV LAB	0	0	3	2	3	50
	TOTAL			**16**	**4**	**12**	**28**	**32**	**700**

Course Code	XBT4001			
Course Title	Bioinformatics			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

To introduce the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

Course Outcome:

CO1: Able to generate interdisciplinary thinking towards advances in bioinformatics and computational biology.

CO2: Able to gather information about computational tools and approaches to extract information from different types of bioinformatics data (gene, protein, disease, etc.) and to analyze them in their area of future research work. Able to develop basic understanding of how biological data is stored and retrieved from various biological databases.

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

CO4: Able to have understanding on new drug designing and development through molecular docking

Course Content:

Module 1: **[10L]**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

Module 2: **[14L]**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

Module 3: **[14L]**

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

Module 4: **[10L]**

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Text / Reference Books:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.

3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

CO-PO Mapping:

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

Course Code	XBT4101			
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 objectives:

To introduce the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

Course Outcome:

CO1: Sequence data analysis and use of databases allows students know how data is stored, retrieved and can be used for analysis.

CO2: Experiments are focused on developing interest in comparative study of genes/proteins and their inter relationship.

CO3: Evolutionary studies through phylogenetic tree development revealed the application "Multiple Sequence Alignment".

CO4: Better clarification of the theory.

Suggestive List of Experiments:

1. Sequence information resource **[1 day]**

2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR) **[3 days]**

3. Understanding and using: PDB, Swissprot, TREMBL **[2 days]**

4. Using various BLAST and interpretation of results. **[1 day]**

5. Retrieval of information from nucleotide databases. **[1 day]**

6. Sequence alignment using BLAST. **[1 day]**

7. Multiple sequence alignment using Clustal W. **[1 day]**

Text / Reference Books:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.

3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

CO-PO Mapping:

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

Course Code	XBT4002			
Course Title	Immunology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

To introduce the basic concepts of the immune system and its defence mechanisms. This will help to understand and rationalise concepts related to diseases. The course will help to understand vaccination, monoclonal and polyclonal antibodies production and their importance in therapeutics.

Course Outcome:

CO1: Able to conceptualize the basic mechanisms that regulate immune responses

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

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

CO4: Able to design basic and state-of-the-art experimental methods in immunology.

Course Content:

Module 1: **[15L]**

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Module 2: **[13L]**

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

Module 3: **[12L]**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

Module 4: **[8L]**

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

Text / Reference Books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th 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	3	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	3	-	-	-	-	-	-	-	-	2
CO3	3	1	3	-	-	-	-	-	1	-	-	2
CO4	-	-	-	-	3	-	-	-	-	-	2	3

Course Code	XBT4102			
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 objectives:

To introduce hand on laboratory experience on basic immunological techniques.

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. Differential leucocytes count **[1 day]**
2. Total leucocytes count **[1 day]**
3. Total RBC count **[1 day]**
4. Haemagglutination assay **[1 day]**
5. Haemagglutination inhibition assay **[1 day]**
6. Separation of serum from blood **[1 day]**
7. Double immunodiffusion test using specific antibody and antigen. **[2 days]**
8. ELISA. **[1 day]**

Text / Reference Books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th 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	3	-	2	-	-	-	-	-	-	-	-	3
CO2	-	3	3	3	-	-	-	-	-	-	-	2
CO3	-	1	-	2	-	-	-	-	-	-	-	2
CO4	-	-	-	-	3	-	1	-	-	-	2	3

Course Code	XBT4003			
Course Title	Chemistry II			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

To provide 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. Expose the students to different characteristic reactions of aromatic hydrocarbon, alkyl/ aryl halides, and functional group chemistry.

Course Outcome:

CO1: To demonstrate the energetic of physical, chemical and biological systems

CO2: To predict the effect of reactant(s), temperature and introduction of inert substance in a process

CO3: To know how to prepare buffer solution of a particular pH

CO4: To identify the reactant(s), reagents and products of name reactions

CO5: To interpret the mechanistic pathway of major and minor products with proper stereochemistry

Course Content:

Section A: Physical Chemistry-1

Module 1: Chemical Energetics [10L]

Review of thermodynamics and the laws of thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature- Kirchhoff's equation. Statement of third law of thermodynamics and calculation of absolute entropies of substances.

Module 2: Chemical Equilibrium [6L]

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔGo, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Module 3: Ionic Equilibria [8L]

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Organic Chemistry-2

Module 1: Aromatic Hydrocarbons [6L]

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Module 2: Alkyl and Aryl Halides [8L]

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by- OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Module 3: Alcohols, Phenols and Ethers (Upto 5 Carbons) [10L]

Alcohols: Preparation: Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten-Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, NaHSO3, NH2- groups derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff-Verley reduction.

Text / Reference Books:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).

2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.

5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

7. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

8. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).

9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).

10. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).

11. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

CO-PO Mapping:

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

Course Code	XBT4103			
Course Title	Chemistry II Laboratory			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	1	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

To provide hand on laboratory experience in thermochemistry and pH measurements. This course also designed in such a manner that students have ample scope to perform small scale organic synthesis along with their purification.

Course Outcome:

CO1: To determine enthalpy of neutralization, ionization and hydration

CO2: To prepare and measure the buffer solution of a particular pH

CO3: To perform small scale organic synthesis and will be able to purify the product

Suggestive List of Experiments:

Section A: Physical Chemistry

Thermochemistry (any two/three)

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. Determination of enthalpy of ionization of acetic acid. **[1 day]**

4. Determination of integral enthalpy of solution of salts (KNO3, NH4Cl). **[1 day]**

5. Determination of enthalpy of hydration of copper sulphate. **[1 day]**

Ionic equilibria pH measurements

1. 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]

2. Preparation of buffer solutions: **[2 days]**

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

3. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation. **[1 day]**

2. Criteria of Purity: Determination of melting and boiling points**.** **[2 days]**

3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. (any two)

[3 days]

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Text / Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

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	-	-	-	-	-	2
CO3	3	2	2	3	2	2	-	-	-	-	-	2

Course Code	XBT4004			
Course Title	Drug Designing			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

The objective of this course is to introduced the concept of Drug discovery/Development, its structural effects and action mechanism. The concepts of Lead were introduced using disease models as screens and physiological mechanisms with the Modern "Rational Approach" to Drug Design.

Course outcome:

CO1: Able to describe the process of drug discovery and development

CO2: Able to discuss the challenges faced in each step of the drug discovery process

CO3: Able to gain a basic knowledge of computational methods used in drug discovery

CO4: Able to organise information into a clear report

CO5: Able to demonstrate their ability to work in teams and communicate scientific information effectively

Course Content:

Module 1: **[4L]**

Introduction to The Drug Discovery/Development: Drug Discovery, Drug Development, Source of Drugs, Structural effects on drug action

Module 2: **[8L]**

Approaches to New Drug Discovery: Drugs Derived from Natural Products, Existing Drugs as a Source for New Drug Discovery, Using Disease Models as Screens for New Drug Leads, Physiological Mechanisms: the Modern "Rational Approach" to Drug Design.

Approaches to Lead Optimization:

1. Bioisosteric replacement

2. Conformation restriction

    a. Increase selectivity, b. Increase affinity

3. Pharmacophore

4. Molecular dissection

5. Metabolic stabilization

Module 3:

Enzymes as Targets of Drug Design: Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors

Module 4: **[4L]**

Receptors as Targets of Drug Design: Receptor Theory, Receptor Complexes and Allosteric Modulators, Second and Third Messenger Systems, Molecular Biology of Receptors, Receptor Models and Nomenclature, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists

Module 5: **[6L]**

Prodrug Design and Applications: Definition, Applications, Prodrug Design Considerations, Prodrug Forms of Various Functional Groups, Ester prodrugs of compounds containing –COOH or –OH, Prodrugs of compounds containing amides, imides, and other acidic NH, Prodrugs of Amines, Prodrugs for compounds containing carbonyl groups

Drug release and activation mechanisms:

1. Simple one-step activation

2. Cascade release/activation systems

Module 6: **[2L]**

Computer-Aided Drug Design: Docking and virtual screening, Molecular Dynamics and binding free energy methods

Text / Reference Books:

1. Organic Chemistry of drug design and drug action by Richard. B. Silverman

2. Computational and Structural Approaches to Drug Discovery: Ligand-Protein Interactions Editors: Robert Stroud, Janet Finer-Moore

3. Drug Design Strategies Computational Techniques and Application Edited by Timothy Clark and Lee Banting

4. Bioinformatics Principles and Applications by Zhumur Ghosh

CO-PO Mapping:

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

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

Course Code	XBT4005			
Course Title	Basics Of Forensic Science			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

This course aims to provide in depth knowledge of forensic science, it's disciplines and importance and working in forensic science laboratory.

Course outcome:

CO1: Able to understand about the basics and different target areas for forensic studies.

CO2: Able to understand about the working and functioning of Forensic science laboratories.

Course Content:

Module 1: **[8L]**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Module 2: **[6L]**

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Module 3: **[4L]**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Module 4: **[6L]**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Text / Reference Books:

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).

3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).

4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).

5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).

6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)

CO-PO Mapping:

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

Course Code	XBT4006			
Course Title	Molecular Diagnostics			
Category	SEC			
LTP & Credits	L	T	P	Credits
	2	0	0	2
Total Contact Hours	24			
Pre-requisites	None			

Learning objectives:

The objective of the course is to make the student familiar to the procedures used in a Laboratory of Molecular Diagnostics. The course will describe the techniques commonly used in diagnostics and molecular pathology laboratories and the underlying principles and applications, advantages and limitations of each technique

Course outcome:

CO1: Able to identify the role and importance of molecular diagnostics such as real-time PCR, epidemiological genotyping, microfluidics, bio-imaging, sequencing technologies and immuno-diagnostics

CO2: Able to assess the benefit of research and development practices within a biotechnology company

CO3: Able to incorporate both in silico and lab-based techniques as part of a combined molecular diagnostics strategy.

CO4: Able to perform selected laboratory techniques, interpret results and prepare reports.

Course Content:

Module 1: **[8L]**

Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

Module 2: **[6L]**

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

MODULE 3: **[6L]**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

MODULE 4: **[4L]**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

Text / Reference Books:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

2. Bioinstrumentation, Webster

3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic

4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.

7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.

8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

9. Microscopic Techniques in Biotechnology, Michael Hoppert

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
CO4	2	-	1	-	2	-	-	-	-	1	2	2

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

Learning objectives:

This course explores the origin of life on our planet, from the emergence of cells to the appearance of humans. The course will provide an overview of the major groups of plant and animal fossils, including critical evaluation of numerous fossil specimens, and an understanding how fossils, microfossils and molecular fossils are used to reconstruct ancient environments and ecosystems.

Course outcome:

CO1: Able to demonstrate an understanding of the geological, chemical and biological processes that determined the co-evolution of life

CO2: Able to interpret the evolutionary and ecological significance of the form and function of fossils of extinct organisms;

CO3: Able to synthesize knowledge about evolutionary biological and geological processes

CO4: Able to perform independent research on a paleontological or geobiological subject.

Course content:

Module 1: **[6L]**

Life through ages Fossils and chemical remains of ancient life. Geological Time Scale with emphasis on major bio-events. Fossilization processes and modes of fossil preservation. Exceptional preservation sites- age and fauna

Module 2: **[6L]**

Geobiology Biosphere as a system, processes and products Biogeochemical cycles Abundance and diversity of microbes, extremophiles Microbes-mineral interactions, microbial mats

Module 3: **[10L]**

Origin of life, Possible life sustaining sites in the solar system, life sustaining elements and isotope records Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the

oxygen revolution and radiation of life Precambrian macrofossils – The garden of Ediacara The Snow Ball Earth Hypothesis

Module 4: **[6L]**

Paleozoic Life The Cambrian Explosion. Biomineralization and skeletalization Origin of vertebrates and radiation of fishes Origin of tetrapods - Life out of water Early land plants and impact of land vegetation

Module 5: **[6L]**

Mesozoic Life Life after the largest (P/T) mass extinction, life in the Jurassic seas Origin of mammals Rise and fall of dinosaurs Origin of birds; and spread of flowering plants

Module 6: **[8L]**

Cenozoic Life Aftermath of end Cretaceous mass extinction – radiation of placental mammals Evolution of modern grasslands and co-evolution of hoofed grazers Rise of modern plants and vegetation Back to water – Evolution of Whales

Module 7: **[6L]**

The age of humans Hominid dispersals and climate setting Climate Change during the Phanerozoic - continental break-ups and collisions Plate tectonics and its effects on climate and life Effects of life on climate and geology

Text / Reference Books:

1. Stanley, S.M., 2008 Earth System History

2. Jonathan I. Lumine W.H.Freeman Earth-Evolution of a Habitable World, Cambridge University Press.

3. Canfield, D.E. & Konhauser, K.O., 2012 Fundamentals of Geobiology Blackwell

4. Cowen, R., 2000 History of Life, Blackwell

CO-PO Mapping:

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

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

Learning objectives:

This course explores the origin of life on our planet, from the emergence of cells to the appearance of humans. The course will provide an overview of the major groups of plant and animal fossils, including critical evaluation of numerous fossil specimens, and an understanding how fossils, microfossils and molecular fossils are used to reconstruct ancient environments and ecosystems.

Course outcome:

CO1: Able to understand fossil preservation techniques

CO2: Able to preserve cell and specimens

CO3: Able to study fossils

Suggestive list of experiments:

1. Study of mode of fossil preservation **[1 day]**
2. Cell preservation by glycerol stock **[1 day]**
3. Cell/enzyme preservation by calcium- sodium alginate **[2 days]**
4. Preservation of specimen using formalin (animal) **[1 day]**
5. Preservation of specimen using glycerol (plant) **[1 day]**
6. Study of fossils from different stratigraphic levels **[1 day]**
7. Observation of flora and fauna inside coal piece **[1 day]**
8. Observation of flora and fauna underside of stone **[1 day]**
9. Exercise related to major evolution **[1 day]**
10. Observation of chlorophyll under microscope in algae **[1 day]**

Text / Reference Books:

1. Stanley, S.M., 2008 Earth System History

2. Jonathan I. Lumine W.H.Freeman Earth-Evolution of a Habitable World, Cambridge University Press.

3. Canfield, D.E. & Konhauser, K.O., 2012 Fundamentals of Geobiology Blackwell 4. Cowen, R., 2000 History of Life, Blackwell

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	2	2	-	-	-	-	-	-	-	2
CO2	-	1	2	1	-	-	-	1	-	-	-	-
CO3	3	-	3	-	-	-	-	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 B.Sc. Biotechnology Semester-5

SEMESTER-5									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT5001	BIOPROCESS TECHNOLOGY	3	1	0	4	4	100
2	CORE	XBT5002	RECOMBINANT DNA TECHNOLOGY	3	1	0	4	4	100
3	DSE I		DISCIPLINE CENTRIC SUBJECTS I	3	1	0	4	4	100
4	DSE II		DISCIPLINE CENTRIC SUBJECTS II	3	1	0	4	4	100
PRACTICAL									
5	CORE	XBT5101	BIOPROCESS TECHNOLOGY LAB	0	0	3	2	3	50
6	CORE	XBT5102	RECOMBINANT DNA TECHNOLOGY LAB	0	0	3	2	3	50
7	DSE I		DISCIPLINE CENTRIC SUBJECTS I LAB	0	0	3	2	3	50
8	DSE II		DISCIPLINE CENTRIC SUBJECTS II LAB	0	0	3	2	3	50
	TOTAL			**12**	**4**	**12**	**24**	**28**	**600**

Course Code	XBT5001			
Course Title	Bioprocess Technology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

To familiarize students with technical and biological aspect of microbial utilisation for production of metabolites

Course outcome:

CO1: Able to understand the basic concept of fermentation and manipulations to enhance production of bioresource products.

CO2: Able to acquire knowledge of various types of substrates that can be utilized in the fermentation industry; type of fermentation that can be efficiently utilized for bioconversion of various low value substrates into value added products.

CO3: Able to implement the principles of fermentation technology for the production of numerous products of huge market value.

Course Content:

Module 1: **[9L]**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

Module 2: **[15L]**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

Module 3: **[12L]**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

Module 4: **[12L]**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

Text / Reference Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. 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	3	2	-	-	-	-	-	-	-	-	-	3
CO2	3	2	-	-	-	-	-	-	1	-	-	2
CO3	-	3	-	-	-	-	-	-	2	-	2	-

Course Code	XBT5101			
Course Title	Bioprocess Technology			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

To familiarize students with technical and biological aspect of microbial utilisation for production of metabolites.

Course outcome:

CO1: Well versed grasp of the basic concepts of fermentation process.

CO2: Knowhow of process design and optimization needed for commercial production of biologicals.

CO3: Ability to recognize components of a fermenter and perform efficient modification in fermenter design.

CO4: Ability to lead and work in team towards achieving upstream and downstream process goals.

Suggestive List of Experiments:

1. Bacterial growth curve. **[2 days]**

2. Calculation of thermal death point (TDP) of a microbial sample. **[2 days]**

3. Production and analysis of ethanol. **[2 days]**

4. Production and analysis of amylase. **[2 days]**

5. Production and analysis of lactic acid. **[2 days]**

6. Isolation of industrially important microorganism from natural resource. **[2 days]**

Text / Reference Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. 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	3	1	-	-	-	-	-	-	-	-	-	3
CO2	3	2	-	-	-	-	-	-	2	-	-	2
CO3	-	3	-	2	-	-	-	-	-	-	-	2
CO4	-	-	3	-	-	-	2	-	-	-	2	-

Course Code	XBT5002			
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 objectives:

The course aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and vehicles for suitable manipulation of genes.

Course outcome:

CO1: Able to understand and employ the latest techniques employed in recombinant DNA technology related to DNA manipulation in prokaryotes and eukaryotes.

CO2: Able to understand the importance of gene cloning, methods for screening cloned genes, DNA sequencing, gene expression, etc.

CO3: Able to understand the importance of recombinant DNA technology in production of insulin, drugs, diagnostics, vaccines and transgenic organisms.

Course Content:

Module 1: **[16L]**

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

Module 2: **[12L]**

Restriction and modification system, restriction mapping. Southern and Northern hybridization.

Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering.

Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Module 3: **[10L]**

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Module 4: **[10L]**

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Text / Reference Books:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

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

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

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

5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

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	2	-	-	-	-	-	-	-	-	-	2
CO3	-	3	2	2	-	-	-	-	-	-	-	2

Course Code	XBT5102			
Course Title	Recombinant DNA technology laboratory			
Category	Core course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The course aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and vehicles for suitable manipulation of genes.

Course outcome:

CO1: Students will take practical training in the recent techniques of recombinant DNA technology such as quantification of DNA, isolation of chromosomal DNA, isolation of plasmid DNA from bacterial cells, restriction digestion of DNA and their separation using Agarose gel electrophoresis, amplification of DNA fragment by PCR.

CO2: With learning these techniques students will gain expertise to work further in the area of recombinant DNA technology.

Suggestive List of Experiments:

1. Isolation of chromosomal DNA from plant cells **[1 day]**
2. Isolation of chromosomal DNA from E.coli **[2 day]**
3. Qualitative and quantitative analysis of DNA using spectrophotometer **[1 day]**
4. Plasmid DNA isolation **[2 days]**
5. Restriction digestion of DNA **[1 day]**
6. Making competent cells **[2 days]**
7. Transformation of competent cells. **[2 days]**
8. Demonstration of PCR **[1 day]**

Text / Reference Books:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

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

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

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

5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

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	2	2	-	1	-	-	-	-	-	-	2

Course Code	XBT5003			
Course Title	Animal Biotechnology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

This subject focusses on providing students with a theoretical and practical understanding of animal biotechnology. The subject covers animal molecular biology, recombinant DNA technology, production of transgenic animals, reproductive biotechnology, biotechnology in animal breeding and ethics.

Course outcome:

CO1: Able to use different molecular biology techniques and genetic engineering to improve sustainability, productivity and suitability for pharmaceutical, agricultural and industrial applications.

CO2: Able to learn about different diseases in animal, their pathogenesis and cure.

CO3: Able to understand principles of animal culture, media preparation.

CO4: Able to learn basics of DNA isolation from various sources

Course Content:

Module 1: **[10L]**

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

Module 2: **[10L]**

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.

Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

Module 3: **[14L]**

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

Module 4: **[14L]**

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Text / Reference Books:

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.

2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.

4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

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

Course Code	XBT5103			
Course Title	Animal Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

This subject focusses on providing students with a theoretical and practical understanding of animal biotechnology. The subject covers animal molecular biology, recombinant DNA technology, production of transgenic animals, reproductive biotechnology, biotechnology in animal breeding and ethics.

Course outcome:

CO1: Able to understand principles of animal culture, media preparation.

CO2: Able to understand basics of DNA isolation from various sources

Suggestive List of Experiments:

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization **[2 days]**

2. Sources of contamination and decontamination measures. **[1 day]**

3. Preparation of Hanks Balanced salt solution **[1 day]**

4. Preparation of Minimal Essential Growth medium **[1 day]**

5. Isolation of lymphocytes for culturing **[1 day]**

6. DNA isolation from animal tissue **[1 day]**

7. Quantification of isolated DNA. **[1 day]**

8. Resolving DNA on Agarose Gel. **[1 day]**

Text / Reference Books:

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.

2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.

4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

CO-PO Mapping:

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

Course Code	XBT5004			
Course Title	Medical Biotechnology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

To understand the application of biotechnology in biomedical research like vaccine development, gene therapy, drug delivery and tissue engineering.

Course outcome:

CO1: Able to understand gene therapy, model and different methods of gene delivery

CO2: Able to understand vaccine development and different tissue engineering process

CO3: Able to understand recent approaches of drug delivery.

CO4: Able to understand cell culture technique

Course Content:

Module 1: Gene therapy **[6L]**

Background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics.

Module 2: Gene Delivery methods **[8L]**

Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non-viral delivery, Antibody engineering.

Module 3: Gene therapy Models **[8L]**

Liver diseases, Lung diseases, Hematopoietic diseases, Circulated gene products, Cancer & Auto-immune diseases.

Module 4: Vaccines **[4L]**

Vaccine vectors, nucleic acid vaccines, immuno-enhancing technology.

Module 5: Synthetic therapy **[6L]**

Synthetic DNAs, therapeutic Ribozymes, synthetic drugs.

Module 6: Tissue Engineering **[4L]**

Skin, Liver, Pancreas.

Module 7: Xenotransplantation **[6L]**

Terminology, technology behind it, organ donors, social & ethical issues.

Module 8: Cell Adhesion-based therapy **[6L]**

Integrins, inflammation, cancer & metastasis.

Module 9: Drug delivery **[6L]**

Conventional & new approaches to drug delivery.

Text / Reference Books:

1. Albert Sasson. Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 2005.

2. Lee Yaun Kun. Microbial Biotechnology Principles and applications. World Science publications, 2004

3. Michels et al., Genetic techniques for Biological Research. Wiley Publications, 2002.

4. Glazer AN, Nikaido H. Microbial Biotechnology Fundamentals of Applied Microbiology WH Freeman, New York 1994.

5. Vyas. Methods in Biotechnology and Bioengineering, CBS publications, 2003.

6. Marshak et al., Stem cell Biology. CSHL publications, 2002.

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	2	-	2	-	-	-	-	-	-	-	3
CO3	3	-	2	3	-	-	-	-	-	-	-	2
CO4	2	2	-	2	-	-	-	-	-	-	-	2

Course Code	XBT5104			
Course Title	Medical Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

To understand the application of biotechnology in biomedical research like vaccine development, gene therapy, drug delivery and tissue engineering.

Course outcome:

CO1: Able to understand cell culture technique

CO2: Able to understand karyotyping and how pedigree analysis is done

CO3: Able to perform selected laboratory techniques, interpret results and prepare reports

Suggestive List of Experiments:

1. Extraction and Quantification of genomic DNA/ plasmid DNA **[2 days]**
2. Estimation of Protein samples **[1 day]**
3. Detection of DNA damage by comet assay **[1 day]**
4. Demonstration on RFLP **[2 days]**
5. Cell culture technique **[2 days]**
6. Demonstration of Karyotyping of normal & abnormal human chromosome sets **[2 days]**
7. Demonstration of Human pedigree analysis **[1 day]**

Text / Reference Books:

1. Albert Sasson. Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 2005.

2. Lee Yaun Kun. Microbial Biotechnology Principles and applications. World Science publications, 2004

3. Michels et al., Genetic techniques for Biological Research. Wiley Publications, 2002.

4. Glazer AN, Nikaido H. Microbial Biotechnology Fundamentals of Applied Microbiology WH Freeman, New York 1994.

5. Vyas. Methods in Biotechnology and Bioengineering, CBS publications, 2003.

6. Marshak et al., Stem cell Biology. CSHL publications, 2002.

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	2	-	2	-	-	-	-	-	-	-	3
CO3	-	-	2	1	2	-	-	-	-	-	1	2

Course Code	XBT5005			
Course Title	Ecology And Environmental Management			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

This course will offer insights into ecosystem and environment and how biotechnology can contribute towards sustainable development

Course outcome:

CO1: Able to provide definitions of environment, management, systems in relation to environmental management

CO2: Able to explain how environmental management can be used as environmental protection and how organizations can define and manage risk.

CO3: Provide the knowledge on different ecological interactions contribute towards sustainable development

CO4: Provide the knowledge on evolution as a consequence of ecological succession

Course Content:

Module 1: **[10L]**

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

Module 2: **[16L]**

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids,

Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

Module 3: **[12L]**

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations, Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup: Case studies

Module 4: **[10L]**

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

Text / Reference Books:

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.

2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.

3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House

4. Joseph, B., Environmental studies, Tata Mc Graw Hill.

5. Michael Allabay, Basics of environmental science, Routledge Press.

6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.

7. Mohapatra Textbook of environmental biotechnology IK publication.

8. Rana SVS, Environmenta lpollution – health and toxicology, Narosa Publication

9. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.

10. Thakur, I S, Environmental Biotechnology, I K Publication.

CO-PO Mapping:

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

Course Code	XBT5105			
Course Title	Ecology And Environmental Management Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

This course will offer insights into ecosystem and environment and how biotechnology can contribute towards sustainable development

Course outcome:

CO1: Able to distinguish between biotic and abiotic factors

CO2: Able to calculate diversity index of a community

CO3: Able to understand basics of soil types and how these are important in industries

CO4: Able to understand the importance of conservation

Suggestive List of Experiments:

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem. **[1 day]**

2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community. **[1 day]**

3. Principle of GPS (Global Positioning System). **[1 day]**

4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data. **[1 day]**

5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon **[1 day]**

6. Study any five endangered/ threatened species- one from each class. **[1 day]**

Text / Reference Books:

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.

2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.

3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House

4. Joseph, B., Environmental studies, Tata Mc Graw Hill.

5. Michael Allabay, Basics of environmental science, Routledge Press.

6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.

7. Mohapatra Textbook of environmental biotechnology IK publication.

8. Rana SVS, Environmenta lpollution – health and toxicology, Narosa Publication

9. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.

10. Thakur, I S, Environmental Biotechnology, I K Publication.

CO-PO Mapping:

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

Course Code	XBT5006			
Course Title	Environmental Biotechnology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

The objective of this course is to instigate the students to the hazards of our environment, the effects of pollution on living systems and solutions to protect the environment for sustainable development.

Course outcome:

CO1: Able to evaluate the potential of biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, into consideration

CO2: Able to understand the phenomenon of phytoremediation for the decontamination of soil and water, wetlands as treatment processes, biofilms/biofilters for vapor-phase wastes, and composting

CO3: Able to learn about the environmental quality evaluation, monitoring, and remediation of contaminated environments

CO4: Able to learn about the use of biosensors in environmental analysis, environmental engineering.

Course Content:

Module 1: **[12L]**

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol

Module 2: **[14L]**

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents.

Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

Module 3: **[12L]**

Treatment of municipal waste and Industrial effluents. Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

Module 4: **[10L]**

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Text / Reference Books:

1. Environmental Science, S.C. Santra

2. Environmental Biotechnology, Pradipta Kumar Mohapatra

3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter

4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

5. Agricultural Biotechnology, S.S. Purohit

6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer

7. Introduction to Environmental Biotechnology, Milton Wainwright

8. Principles of Environmental Engineering, Gilbert Masters

9. Wastewater Engineering – Metcalf & Eddy

CO-PO Mapping:

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

Course Code	XBT5106			
Course Title	Environmental Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	L
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The objective of this course is to instigate the students to the hazards of our environment, the effects of pollution on living systems and solutions to protect the environment for sustainable development.

Course outcome:

CO1: Able to calculate TDS of any water sample

CO2: Able to calculate BOD and COD of water samples

CO3: Able to examine bacterial contamination in water

Suggestive List of Experiments:

1. Calculation of Total Dissolved Solids (TDS) of water sample. **[1 day]**
2. Calculation of BOD of water sample. **[2 days]**
3. Calculation of COD of water sample. **[2 days]**
4. Bacterial Examination of Water by MPN Method. **[2 days]**

Text / Reference Books:

1. Environmental Science, S.C. Santra

2. Environmental Biotechnology, Pradipta Kumar Mohapatra

3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter

4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

5. Agricultural Biotechnology, S.S. Purohit

6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer

7. Introduction to Environmental Biotechnology, Milton Wainwright

8. Principles of Environmental Engineering, Gilbert Masters

9. Wastewater Engineering – Metcalf & Eddy

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	2	-	2	-	-	-	-	-	-	-	2
CO3	2	1	-	2	-	-	-	-	1	-	-	2

Detail Syllabus B.Sc. Biotechnology Semester-6

SEMESTER-6									
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**	**MARKS**
THEORY									
1	CORE	XBT6001	BIOSTATISTICS	3	1	0	4	4	100
2	CORE	XBT6002	GENOMICS AND PROTEOMICS	3	1	0	4	4	100
3	DSE I		DISCIPLINE CENTRIC SUBJECTS III	3	1	0	4	4	100
4	DSE II		DISCIPLINE CENTRIC SUBJECTS IV	3	1	0	4	4	100
PRACTICAL									
5	CORE	XBT6101	BIOSTATISTICS LAB	0	0	3	2	3	50
6	CORE	XBT6102	GENOMICS AND PROTEOMICS LAB	0	0	3	2	3	50
7	DSE I		DISCIPLINE CENTRIC SUBJECTS III LAB	0	0	3	2	3	50
8	DSE II		DISCIPLINE CENTRIC SUBJECTS IV LAB	0	0	3	2	3	50
	TOTAL			**12**	**4**	**12**	**24**	**28**	**600**

Course Code	XBT6001			
Course Title	Biostatistics			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

The objective of this course is to introduce students to statistical methods and to understand the underlying principles. The course will introduce a statistical perspective on information from biology and basic critical skills to assess the quality of research evidence.

Course outcome:

CO1: Able to use various graphical and pictorial representation for presenting data

CO2: Able to understand the theoretical working of probability and statistical concepts.

CO3: Able to evaluate the various statistical techniques to solve statistical problems

CO4: Able to compute the probability of real-world uncertain phenomena by identifying probability distribution that fits the phenomena.

CO5: Able to analyze statistical techniques in solving problems related to their field.

CO6: Able to predict the significance of experiment using statistical methods.

Course Content:

Module 1: **[8L]**

Random Experiment, Outcome, Event, Mutually exclusive events, Equality like and exhaustive, Classical definition of probability, conditional probability and statistical independence. Sequencial definition of probability. Baye's theorem and related problems. Axiomatic approach of probability. Exercise.

Module 2: **[6L]**

Random variable. Probability space .Expectation. Theorems on Expectation. Joint distribution of two random variables.

Module 3: **[8L]**

Probability distribution- Continuous and Discrete. Probability Density function. Probability Mass function. Binomial , Poisson, Normal and Rectangular distributions and their properties.

Module 4: **[10L]**

Elements of Statistical methods. Primary data and secondary data. Population and sample. Sample survey. Chart and diagram. Frequency distribution. Measure of central Tendencies- Mean , Median and Mode. Standard Deviation, Varience. Moment , Skewness and Kurtosis.

Module 5: **[8L]**

Sampling distribution. Fundamental distributions- Standard normal distribution, Chi- square Distribution.

Module 6: **[8L]**

Bivariate Frequency Distribution. Correlation and Co-efficient. Regression lines. Curve fittings.

Text / Reference Books:

1. Fundamental of Statistics – Himalaya Publishing House- S.C.Guptha

2. Statistical Methods, N. G. Das: TMH.

3. Statistics Theory, Method & Application Sancheti , D. S. & Kapoor ,V.K. , Sultan chand & sons, New Delhi

4. Essential Biostatistics: A Nonmathematical Approach, Harvey Motulsky Oxford University Press; Illustrated edition (June 30, 2015)

5. Biostatistics for the Biological and Health Sciences, Marc Triola, Mario F. Triola, Jason Roy**,** Pearson; 2nd edition (January 1, 2017)

6. An Introduction to Biostatistics, Thomas Glover, Waveland Press, Inc.; 3rd edition (June 29, 2015)

7. Introduction to Biostatistics, P K Banerjee, S. Chand Publishing

CO-PO Mapping:

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

Course Code	XBT6101			
Course Title	Biostatistics Lab			
Category	Core Course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The objective of this course is to introduce students to statistical methods and to understand the underlying principles. The course will introduce a statistical perspective on information from biology and basic critical skills to assess the quality of research evidence.

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 biological samples.

Suggestive List of Experiments:

1. Word Problems based on Differential Equations **[1 day]**
2. Mean, Median, Mode from grouped and ungrouped Data set **[3 days]**
3. Standard Deviation and Coefficient of Variation **[2 days]**
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 **[1 day]**

Text / Reference Books:

1. Fundamental of Statistics – Himalaya Publishing House- S.C.Guptha

2. Statistical Methods, N. G. Das: TMH.

3. Statistics Theory, Method & Application Sancheti , D. S. & Kapoor ,V.K. , Sultan chand & sons, New Delhi

4. Essential Biostatistics: A Nonmathematical Approach, Harvey Motulsky Oxford University Press; Illustrated edition (June 30, 2015)

5. Biostatistics for the Biological and Health Sciences, Marc Triola, Mario F. Triola, Jason Roy**,** Pearson; 2nd edition (January 1, 2017)

6. An Introduction to Biostatistics, Thomas Glover, Waveland Press, Inc.; 3rd edition (June 29, 2015)

7. Introduction to Biostatistics, P K Banerjee, S. Chand Publishing

CO-PO Mapping:

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

Course Code	XBT6002			
Course Title	Genomics & proteomics			
Category	Core course			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

To evaluate the key concepts of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course outcome:

CO1: Able to discuss how information network in biological systems work as a part of omics technology relating to genes, proteins and cellular structures.

CO2: Able to investigate proteomics expression pattern of different proteins and how they are affected by cell processes or the external environment.

CO3: Able to list set of proteins produced in different tissues and how they are dependent on gene expression.

CO4: Able to acquire the techniques used in functional genomics such as microarrays, NGST, mRNA expression and miRNA expression

CO5: Able to outline solution to theoretical and experimental problems in Genomics, Transcriptomics and Proteomics fields.

Course Content:

Module 1: **[12L]**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Module 2: **[8L]**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

Module 3: **[16L]**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

Module 4: **[12L]**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

Text / Reference Books:

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.

2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.

4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.

5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.

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

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

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

9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

10. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

CO-PO Mapping:

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

Course Code	XBT6102

Course Title	Genomics & proteomics lab			
Category	Core course			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

To evaluate the key concepts of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course outcome:

CO1: Able to demonstrate skills to apply the knowledge in scientific queries.
CO2: Able to understand the cause of genome diversity through SNPs.

CO3: Able to understand predictive software and enable to identify ORFs.

CO4: Able to study protein localization and its nature using various web resources.

Suggestive List of Experiments:

1. Use of SNP databases at NCBI and other sites **[1 day]**
2. Use of OMIM database **[1 day]**
3. Detection of Open Reading Frames using ORF Finder **[1 day]**
4. Proteomics 2D PAGE database **[1 day]**
5. Softwares for Protein localization. **[1 day]**
6. Hydropathy plots **[1 day]**
7. Native PAGE **[2 days]**
8. SDS-PAGE **[2 days]**

Text / Reference Books:

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.

2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.

5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.

6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.

7. 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). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

CO-PO Mapping:

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

Course Code	XBT6003

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

Learning objectives:

The aim of this course is to introduce the basic concepts in Industrial Biotechnology. It will cover concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale

Course outcome:

CO1: Able to illustrate the various aspects of Biotechnological applications in Fermentation Industries.

CO2: Able to describe the principles underlying design of Fermenters, Fermentation Process and downstream processing and its applications.

CO3: Able to integrate scientific and technological knowledge on the use of bioprocesses for industrial products

CO4: Able to enhance the knowledge regarding valorisation of agro-industrial by-products

Course Content:

Module 1: **[6L]**

Commercial Production of Microorganisms: Industrial Fermenters, Single-cell Protein.

Module 2: **[8L]**

Bioconversions: Biomining and bioleaching of ores (Use of thermophilic microorganisms in industrial microbiology Bio-gas, Bio-leaching, Bio-diesel.

Module 3: **[8L]**

Microorganisms & Agriculture: Microorganisms in Agricultural Waste water treatment, Vermiculture, Microbial pesticides.

Module 4: **[6L]**

Products from Microorganisms: Metabolites, Enzymes, Antibiotics.

Module 5: **[4L]**

Bioremediation: Petroleum prospecting and formation of oil spills, Wastewater treatment, chemical degradation, heavy Metals.

Module 6: **[6L]**

Principles of Microbial growth: introduction, the ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures (definition and kinetics).

Module 7: **[6L]**

Downstream processing: extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites), Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid, α-amylase, protease penicillin, tetracycline and vitamin B12, with reference to easily available raw materials, Production of herbal drugs. .

Module 8: **[4L]**

Biological fuel generation: photosynthesis, sources of biomass, ethanol from biomass, methane from biomass, hydrogen, microbial recovery of petroleum.

Text / Reference Books:

1. Industrial Microbiology (1992): 4th edition-Prescott & Dunn.,CBS

2. Prespectives in Biotechnology and applied Microbiology. Elsevier Publication, Alani,D.I., and Murray Moo-Young (1986):

3. Applied Microbiology (1968) Cassida Jr. Tata McGraw hill. Microbiology- Concepts and applications (1994): Paula A.Ketchun

4. Fermentation Technology -(1998) Staneberry et al.

5. Molecular Biotechnology -Principles & applications of Recombinant DNA - Bernad R.Glick and JackJ.Pasternak.

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

Course Code	XBT6103			
Course Title	Industrial Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The aim of this course is to introduce the basic concepts in Industrial Biotechnology. It will cover concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale

Course outcome:

CO1: Able to culture bacteria in different culture media using different technique.

CO2: Able to understand the process of fermentation and how it can be used in industry.

CO3: Able to estimate enzymes, amino acids and organic acids.

Suggestive List of Experiments:

1. Bacterial growth curve **[2 days]**

2. Bacterial thermal death point **[2 days]**

3. comparison Batch culture, continuous culture **[1 day]**

4. isolation of bacterial colony by streak plate and spread plate from natural sources **[2 days]**

5. isolation of bacterial colony by using serial dilution (spread plate) **[2 days]**

6. alcohol fermentation process with yeast **[2 days]**

7. Isolation of fermenting bacteria from curd **[2 days]**

8. demonstration: Microbial fermentations for the production and estimation (qualitative and quantitative) of: **[3 days]**

   a) demonstration: Enzymes: Amylase and Protease

   b) demonstration: Amino acid: Glutamic acid

   c) demonstration: Organic acid: Citric acid

Text / Reference Books:

1. Industrial Microbiology (1992): 4th edition-Prescott & Dunn.,CBS

2. Prespectives in Biotechnology and applied Microbiology. Elsevier Publication, Alani,D.I., and Murray Moo-Young (1986):

3. Applied Microbiology (1968)Cassida Jr. Tata McGraw hill. Microbiology- Concepts and applications (1994): Paula A.Ketchun

4. Fermentation Technology -(1998) Staneberry et al.

5. Molecular Biotechnology -Principles & applications of Recombinant DNA - Bernad R.Glick and JackJ.Pasternak.

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	2	2	-	-	-	-	-	-	-	-	2
CO3	2	2	2	2	-	-	-	-	-	-	-	2

Course Code	XBT6004			
Course Title	Plant Biotechnology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

This course will be helpful for the students to understand various parts of the plant tissue culture technique, with each type of culture having specific applications. Will be able to shed light on the production of transgenic plants which have various applications.

Course outcome:

CO1: Able to establish different types of plant tissue culture of agronomic interest

CO2: Able to apply the technical skills learnt to establish nurseries for horticultural and agricultural crops.

CO3: Able to compare the pros and cons of transgenic plants on environment

CO4: Able to explain the concepts of intellectual property management and handling of GMOs.

Course Content:

Module 1: **[10L]**

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

Module 2: **[14L]**

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

Module 3: **[16L]**

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation. Nomenclautre, methods, applications basis and disadvantages.

Module 4: **[8L]**

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

Text / Reference Books:

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.

2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.

3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.

4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.

5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.

6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.

7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)

8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	1	2	-	-	-	-	-	-	-	2
CO 2	-	3	2	2	-	-	-	-	-	-	-	2
CO 3	2	2	2	-	-	2	-	-	-	-	-	2
CO 4	3	2	-	-	-	1	-	-	1	-	1	2

Course Code	XBT6104			
Course Title	Plant Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

This course will be helpful for the students to understand various parts of the plant tissue culture technique, with each type of culture having specific applications.

Course outcome:

CO1: Able to prepare different medium used in plant tissue culture

CO2: Able to identify application areas of plant tissue culture and plant biotechnology

Suggestive List of Experiments:

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid. **[2 days]**

2. Preparation of complex nutrient medium (Murashige & Skoog's medium) **[2 days]**

3. To selection, Prune, sterilize and prepare an explant for culture. **[2 days]**

4. Significance of growth hormones in culture medium. **[1 day]**

5. To demonstrate various steps of Micropropagation. **[2 days]**

Text / Reference Books:

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.

2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.

3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.

4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.

5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.

6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.

7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)

8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Course Code	XBT6005			
Course Title	Food Biotechnology			
Category	DSE			
LTP & Credits	L	T	P	Credits
	3	1	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

This course will inform about the role of microorganisms in many food industries both in production and food spoilage processes along with the beneficial and harmful roles of microorganisms in food industries.

Course outcome:

CO1: Able to acquire knowledge about the constituents, food additives and enzymes in food processing.

CO2: Able to acquire knowledge about the microorganisms associated with food and food borne diseases.

CO3: Able to gain the knowledge of the fundamentals of food processing and understand the techniques involved in the food processing and food preservation.

CO4: Able to acquire the skills to gain employment in the food industry and food product development.

Course Content:

Module 1: **[12L]**

Methods for the microbiological examination of water and foods; Control of Microbiological quality and safety; Food borne illnesses and diseases

Module 2: **[12L]**

Microbial cultures for food fermentation, their maintenance, strain development; Production of organic acids (vinegar, lactic acid), alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka), glycerol

Module 3: **[12L]**

Propagation of baker's yeasts; Microbial production of vitamins (B2 and B12), antibiotics (penicillin, streptomycin, tetracycline); Enzymatic production of glucose, fructose, starch, SCP and mushrooms

Module 4: **[12L]**

Basics of microbial genetics – Gene, DNA, RNA; Replication, transcription, transformation, transduction, conjugation; Regulation of gene expression; Application in GM foods.

Text / Reference Books:

1. Industrial Microbiology Prescott & Dunn, CBS Publishers

2. Modern Food Microbiology by Jay JM, CBS Publishers

3. Comprehensive Biotechnology by Murray & Mooyoung, Academic press

4. Industrial Microbiology by Casida L.R., New Age International Pvt. Ltd.

5. Food Microbiology; Frazier WC; 4th ed, Tata-McGrowhill Pub.

6. Microbiology by Pelczar, Chan, and Krieg, TMH

7. Fermentation Biotechnology, Principles, Processed Products by Ward OP, Open University Press.

CO-PO Mapping:

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

Course Code	XBT6105			
Course Title	Food Biotechnology Laboratory			
Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

This course will inform about the role of microorganisms in many food industries both in production and food spoilage processes along with the beneficial and harmful roles of microorganisms in food industries.

Course outcome:

CO1: Able to understand fermentation process

CO2: Able to understand the preparation of antibiotics, enzymes and amino acid in context of industrial uses

Suggestive List of Experiments:

1. Alcohol fermentation **[2 days]**
2. Organic acid fermentation – Vinegar / citric / lactic acid production **[3 days]**
3. Propagation of baker's yeast **[3 days]**
4. Fermented dairy products **[1 day]**
5. Production of antibiotics **[2 days]**
6. Enzyme preparation **[2 days]**
7. Amino acid production **[2 days]**
8. Vitamin B12 production **[2 days]**

Text / Reference Books:

1. Industrial Microbiology Prescott & Dunn, CBS Publishers
2. Modern Food Microbiology by Jay JM, CBS Publishers
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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	-	2	2	-	-	-	-	-	-	-	2

Course Code	XBT6006

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

Learning objectives:

The course gives an overview of important virus families, their mode of infection to host, their replication strategies and mechanisms for development of viral infectious diseases. It also gives an inclusive idea about viral taxonomy, classification, replication strategies, pathogenicity and transmission of viruses and, additionally, diagnosis, prevention and treatment of viral diseases which includes antiviral immunity and viral evasion. The objective of this course is to help the student learn molecular virology and an overall idea of host viral interaction and pathogenesis.

Course outcome:

CO1: Able to understand the various elements of the viral life cycle.

CO2: Able to explain viral replication strategies; and compare and contrast replication mechanisms used by viruses relevant to public health.

CO3: Able to understand the host antiviral immune mechanisms at a cellular and molecular level.

CO4: Able to understand viral strategies to evade host immune and cellular factors relevant for human diseases.

CO5: Able to discuss principles of virus pathogenesis, vaccination strategies and mechanisms of antiviral drugs.

Course Content:

Module 1: **[6L]**

Classification and Morphology of Viruses: Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultra-structure of viruses. Virus related agents, viroids and prions.

Module 2: **[10L]**

Cultivation and assay of viruses: Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA.

Module 3: **[6L]**

Assay of viruses: Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point) Genetic analysis of viruses by classical genetic methods.

Module 4: **[10L]**

Viral Multiplication: Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.

Module 5: **[10L]**

Pathogenesis of Viruses: Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

Module 6: **[6L]**

Control of Viruses and Emerging Viruses: Control of viral infections through vaccines, interferons and chemotherapeutic agents. Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus. Emerging viruses

Text / Reference Books:

1. Flint S.J., Enquist L.W., Racaniello V.R., Skalka A.M. Principles of Virology, 2008, 3rd edition, ASM Press.

2. David M. Knipe, PhD, Peter M. Howley, MD, Diane E Griffin MD, PhD, Robert A Lamb, PhD, ScD, Malcolm A Martin MD, Bernard Roizman ScD, and Stephen E Straus, MD. Fields Virology , 2007, 5th edition, Lippincott Williams & Wilkins.

3. Edward K. Wagner, Martínez J. Hewlett, David C. Bloom, David Camerini. Basic Virology, 2007, 3rd edition, Wiley-Blackwell.

4. N.J. Dimmock, A.J. Easton, K.N. Leppard. Introduction to Modern Virology 2007, 6th edition, Wiley-Blackwell.

5. K. Murphy, P. Travers, M. Walport. Janeway's Immunobiology , 2011, 8th edition, Garland Science.

6. Teri Shors. Understanding viruses , 2nd ed. Burlington: Jones & Bartlett Learning, cop. 2013

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

Course Code	XBT6106
Course Title	Virology Laboratory

Category	DSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

The Virology Practical course gives an overview of important domain virus families, their mode of infection to host, replication and virion multiplication strategies. The main objective of this course is to understand virus cultivation in the laboratory to study the viral system in depth along with an inclusive idea about viral host-dependent pathogenicity and the utilisation of viral genome in molecular biology-related research on its diagnosis, prevention, and treatment.

Course outcome:

CO1: Able to understand viral infection in plant

CO2: Able to isolate bacteriophage

CO3: Able to identify restriction enzyme sites in bacteriophage genome

Suggested list of experiments:

1. Study of TMV infection on Tomato plant induced by TMV infected tobacco extract.

[1 day]

2. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique **[3 days]**

3. Study of one step phage growth curve using isolated bacteriophages. **[2 days]**

4. Isolation of Bacteriophage DNA and study of its Hind III digestion pattern **[3 days]**

Text / Reference Books:

1. Flint S.J., Enquist L.W., Racaniello V.R., Skalka A.M. Principles of Virology, 2008, 3rd edition, ASM Press.

2. David M. Knipe, PhD, Peter M. Howley, MD, Diane E Griffin MD, PhD, Robert A Lamb, PhD, ScD, Malcolm A Martin MD, Bernard Roizman ScD, and Stephen E Straus, MD. Fields Virology , 2007, 5th edition, Lippincott Williams & Wilkins.

3. Edward K. Wagner, Martínez J. Hewlett, David C. Bloom, David Camerini. Basic Virology, 2007, 3rd edition, Wiley-Blackwell.

4. N.J. Dimmock, A.J. Easton, K.N. Leppard. Introduction to Modern Virology 2007, 6th edition, Wiley-Blackwell.

5. K. Murphy, P. Travers, M. Walport. Janeway's Immunobiology , 2011, 8th edition, Garland Science.

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CO1	3	-	1	-	-	-	-	-	-	-	-	2
CO2	3	-	2	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2