JIS UNIVERSITY

Course Structure & Syllabus for
B.Sc. BIOTECHNOLOGY (R-23)
As per National Education Policy 2020
w.e.f. 2023-2024

Department of Biosciences

B.Sc. Biotechnology

Revised Curriculum Structure to be effective from

2023-2024

Credit Distribution across the Course for 4 years B.Sc. Honors with Research				
Course Type	**Total Papers**	**Credit**		**Total Credit**
		Theory	**Practical**	
Major	16	64	16	**80**
Minor	5	20	12	**32**
Multidisciplinary/ Interdisciplinary Courses (IDC)	3	12	-	**12**
Ability Enhancement Courses (AEC)	4	8		**8**
Skill Enhancement Courses (SEC)	3	9		**9**
Value Added Courses (VAC)	2	6		**6**
Summer Internship		4		**4**
Research Project / Dissertation		20		**20**
TOTAL				**171**

Credit Distribution across the Course for 3 years B.Sc. Degree				
Course Type	**Total Papers**	**Credit**		**Total Credit**
		Theory	**Practical**	
Major	11	44	16	**60**
Minor	5	20	12	**32**
Multidisciplinary/ Interdisciplinary Courses (IDC)	3	12	-	**12**
Ability Enhancement Courses (AEC)	4	8		**8**
Skill Enhancement Courses (SEC)	3	9		**9**
Value Added Courses (VAC)	2	6		**6**
Summer Internship		4		**4**
TOTAL				**131**

Major Courses (16 Papers for the Students of Biotechnology)		Semester	Subject Code
MAJOR I	BIOCHEMISTRY	I	
MAJOR II	METABOLISM	II	
MAJOR III	CELL BIOLOGY	III	
MAJOR IV	MICROBIOLOGY	IV	
MAJOR V	MOLECULAR BIOLOGY		
MAJOR VI	GENETICS	V	
MAJOR VII	RECOMBINANT DNA TECHNOLOGY		
MAJOR VIII	VIROLOGY	VI	
MAJOR IX	IMMUNOLOGY		
MAJOR X	MEDICAL BIOTECHNOLOGY		
MAJOR XI	BIOINFORMATICS		
MAJOR XII	ENVIRONMENTAL BIOTECHNOLOGY	VII	
MAJOR XIII	BIOPROCESS TECHNOLOGY		
MAJOR XIV	DEVELOPMENTAL BIOLOGY		
MAJOR XV	TISSUE CULTURE TECHNOLOGY	VIII	
MAJOR XVI	PROTEIN SEPARATION TECHNOLOGY		

Minor Courses (5 Papers for the Students of Biotechnology)		Semester	Subject Code
MINOR I	ORGANIC CHEMISTRY I	I	
MINOR II	ORGANIC CHEMISTRY II	II	
MINOR III	PHYSICAL CHEMISTRY	III	
MINOR IV	INORGANIC CHEMISTRY	IV	
MINOR V	BIOPHYSICAL CHEMISTRY	V	

Multidisciplinary/ Interdisciplinary Courses (IDC) (3 Papers for the Students of Biotechnology)		Semester	Subject Code
IDC I	Computer Fundamentals	I	
IDC II	Fundamentals of Physics	II	
IDC III	Biomathematics and Biostatistics	III	

Ability Enhancement Courses (AEC) (4 Papers for the Students of Biotechnology)		Semester	Subject Code
AEC I	BASIC ENGLISH	**I**	
AEC II	ENGLISH ADVANCE	**II**	
AEC III	ENTREPRENEURSHIP DEVELOPMENT	**III**	
AEC IV	VALUES AND ETHICS	**IV**	

Skill Enhancement Courses (SEC) (10 Papers for the Students of Biotechnology. Any one paper should be taken by student)		Semester	Subject Code
SEC I	INTELLECTUAL PROPERTY RIGHTS	**I**	
SEC II	ENZYMOLOGY		
SEC III	MOLECULAR DIAGNOSTICS		
SEC IV	BIOFERTILIZERS AND BIOPESTICIDES		
SEC V	STRUCTURAL BIOINFORMATICS	**II**	
SEC VI	FERMENTATIONS TECHNOLOGY		
SEC VII	BASICS OF FORENSIC SCIENCE		
SEC VIII	ANIMAL BIOTECHNOLOGY		
SEC IX	MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES	**III**	
SEC X	MANAGEMENT OF HUMAN MICROBIAL DISEASES		

Value Added Courses (VAC) (4 Papers for the Students of Biotechnology; Any one should be taken by students)		Semester	Subject Code
VAC I	CONSTITUTIONAL LAW	**I**	
VAC II	PUBLIC HEALTH AWARENESS		
VAC III	ENVIRONMENTAL SCIENCE	**II**	
VAC IV	ETHNOMEDICINE/ MUSHROOM CULTURE		

SEMESTER-1								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT1001	Biochemistry	4	0	0	4	4
2	MINOR	XBT1002	Organic Chemistry I	4	0	0	4	4
3	IDC		Computer Fundamentals	4	0	0	4	4
4	AEC		Basic English	2	0	0	2	2
5	SEC		SECI/II/III/IV	3	0	0	3	3
6	VAC		Constitutional Law /Public Health Awareness	3	0	0	3	3
PRACTICAL								
7	MAJOR PRACTICAL	XBT1101	Biochemistry Laboratory	0	0	3	2	3
8	MINOR PRACTICAL	XBT1102	Organic Chemistry I Laboratory	0	0	3	3	3
	TOTAL			**20**	**0**	**6**	**25**	**26**

SEMESTER-2								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT2001	Metabolism	4	0	0	4	4
2	MINOR	XBT2002	Organic Chemistry II	4	0	0	4	4
3	IDC		Fundamentals of Physics	4	0	0	4	4
4	AEC		English Advance	2	0	0	2	2
5	SEC		SECV/VI/VII/VIII	3	0	0	3	3
6	VAC		Environmental science/ Ethnomedicine/ Mushroom Culture	3	0	0	3	3
PRACTICAL								
7	MAJOR PRACTICAL	XBT2101	Biochemistry II Laboratory	0	0	3	2	3
8	MINOR PRACTICAL	XBT2102	Organic Chemistry II Laboratory	0	0	3	3	3
	TOTAL			**20**	**0**	**6**	**25**	**26**

SEMESTER-3								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT3001	Cell Biology	4	0	0	4	4
2	MINOR	XBT3002	Physical Chemistry	4	0	0	4	4
3	IDC		Biomathematics and Biostatistics	4	0	0	4	4
4	AEC		Entrepreneurship Development	2	0	0	2	2
5	SEC		SEC IX/X	3	0	0	3	3
PRACTICAL								
7	MAJOR PRACTICAL	XBT3101	Cell Biology Laboratory	0	0	3	2	3
8	MINOR PRACTICAL	XBT3102	Physical Chemistry Laboratory	0	0	3	2	3
	TOTAL			**17**	**0**	**6**	**21**	**23**

SEMESTER-4								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT4001	Microbiology	4	0	0	4	4
2	MAJOR	XBT4002	Molecular Biology	4	0	0	4	4
3	MINOR	XBT4003	Inorganic Chemistry	4	0	0	4	4
4	AEC		Values and Ethics	2	0	0	2	2
PRACTICAL								
5	MAJOR PRACTICAL	XBT4101	Cell Biology Laboratory	0	0	3	2	3
6	MAJOR PRACTICAL	XBT4102	Molecular Biology Laboratory	0	0	3	2	3
7	MINOR PRACTICAL	XBT4103	Inorganic Chemistry Laboratory	0	0	3	2	3
	TOTAL			**14**	**0**	**9**	**20**	**23**

SEMESTER-5								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT5001	Genetics	4	0	0	4	4
2	MAJOR	XBT5002	Recombinant DNA technology	4	0	0	4	4
3	MINOR	XBT5003	Biophysical Chemistry	4	0	0	4	4
PRACTICAL								
4	MAJOR PRACTICAL	XBT5102	Recombinant DNA technology Laboratory	0	0	3	2	3
5	MINOR PRACTICAL	XBT5103	Biophysical Chemistry Laboratory	0	0	3	2	3
6	SEC	XBT5104	Summer Internship	0	0	0	4	0
	TOTAL			**12**	**0**	**6**	**20**	**18**

SEMESTER-6								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT6001	Virology	4	0	0	4	4
2	MAJOR	XBT6002	Immunology	4	0	0	4	4
3	MAJOR	XBT6003	Medical Biotechnology	4	0	0	4	4
4	MAJOR	XBT6004	Bioinformatics	4	0	0	4	4
PRACTICAL								
5	MAJOR PRACTICAL	XBT6102	Immunology Laboratory	0	0	3	2	3
6	MAJOR PRACTICAL	XBT6104	Bioinformatics Laboratory	0	0	3	2	3
	TOTAL			**16**	**0**	**6**	**20**	**22**

SEMESTER-7								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT7001	Environmental Biotechnology	4	0	0	4	4
2	MAJOR	XBT7002	Bioprocess Technology	4	0	0	4	4
3	MAJOR	XBT7003	Developmental Biology	4	0	0	4	4
PRACTICAL								
5	MAJOR PRACTICAL	XBT7101	Project work	0	0	12	8	12
	TOTAL			**12**	**0**	**12**	**20**	**24**

SEMESTER-8								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT8001	Tissue Culture Technology	4	0	0	4	4
2	MAJOR	XBT8002	Protein Separation Technology	4	0	0	4	4
PRACTICAL								
5	MAJOR PRACTICAL	XBT8101	Project work	0	0	20	12	20
	TOTAL			**8**	**0**	**20**	**20**	**28**

Detail Syllabus B.Sc. Biotechnology Semester-1

SEMESTER-1								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT1001	Biochemistry	4	0	0	4	4
2	MINOR	XBT1002	Organic Chemistry I	4	0	0	4	4
3	IDC		Computer Fundamentals	4	0	0	4	4
4	AEC		Basic English	2	0	0	2	2
5	SEC		SECI/II/III/IV	3	0	0	3	3
6	VAC		Constitutional Law /Public Health Awareness	3	0	0	3	3
PRACTICAL								
7	MAJOR PRACTICAL	XBT1101	Biochemistry Laboratory	0	0	3	2	3
8	MINOR PRACTICAL	XBT1102	Organic Chemistry I Laboratory	0	0	3	3	3
	TOTAL			**20**	**0**	**6**	**25**	**26**

Course Code	XBT1001			
Course Title	BIOCHEMISTRY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning Objective:

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

Course Outcome:

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

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

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

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

Course Content:

Module 1: Biomolecules [12L]

Aqueous solutions: Properties of water, acid bases and buffer; **Amino Acids:** general properties and structure, acid base properties, zwitterion, titration curve of amino acid, optical activity peptide bond, Ninhydrin reaction, natural modifications of amino acids, non-protein amino acids; **Carbohydrate:** aldoses, ketoses, trioses, tetroses, pentoses, hexoses, stereo isomerism, epimers, anomers, mutarotation, furanose and pyranose forms, Haworth projection formula, chair and boat conformation of glucose, sugar derivatives, amino sugars, disaccharides, polysaccharide, basic concept and structure of peptidoglycan; **Lipids:** classification, fatty acids structure and functions, acyl-glycerol, phosphatidylethanolamine, phosphatidylcholine, sphingolipids, cerebrosides, gangliosides, properties of lipid aggregates, introduction of lipid micelles, monolayers, bilayers, biological membrane, FRAP. **Nucleic Acid:** Nucleotides and Nucleic acids, double helical structure of DNA, concept of Hydrogen bond, DNA melting curve,

denaturation and renaturation. Vitamins: Basic concept, classification, vitamins as coenzyme precursors and human deficiency-related diseases.

Module 2: Proteins and peptides: **[12L]**

Peptide bond, Ramachandran plot, disulfide bond, primary, secondary, tertiary and quaternary structure of proteins, physicochemical properties of protein, absorbance, emission isoelectric point, three-dimensional structure of protein: folds, motifs, structure and function relation, globular proteins, fibrous proteins, protein stability, Electrostatic forces, van der Waals forces, dipole-dipole interaction, London dispersion force, hydrogen bond, hydrophobic forces, basic concept of protein folding, structure and mechanism of hemoglobin. Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame.

Module 3: Enzymes: **[14L]**

Introduction to enzymes, active site, substrate specificity, Lock and key hypothesis, induced fit hypothesis, enzyme classification, mechanism of action of enzymes, transition state, activation energy, apoenzyme, holoenzyme, cofactors, prosthetic group, Enzyme kinetics, rapid equilibrium approach (Michaelies-Menten equation), steady-state approach (Briggs and Haldane), significance of Km, double reciprocal plots, reaction order , competitive inhibition, non-competitive inhibition, uncompetitive inhibition, allosteric mechanism, definitions of enzyme unit, specific activity, turnover number, catalytic efficiency ; multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase; effect of pH and temperature on enzyme activity.

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

Laws of Thermodynamics, concept of enthalpy & entropy, Gibb's Free Energy, standard free energy change and equilibrium constant, coupled reactions and additive nature of standard free energy change, concept of energy rich compounds, calculation of standard free energy change and free energy change for a particular biochemical reaction, free energy change for membrane transport, oxidative phosphorylation and chemiosmotic hypothesis.

Text / Reference Books:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
2. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
3. Lehninger Principles of biochemistry, Nelson and Cox, W.H.Freeman and Company

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-

CO 3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XBT1101			
Course Title	BIOCHEMISTRY LABORATORY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

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

Course Outcome:

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

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

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

Suggestive List of Experiments:

1. Preparation of Buffer and pH measurement **[2 days]**

2. Qualitative/Quantitative tests for carbohydrates, reducing sugars **[2 days]**

3. Qualitative/Quantitative estimation of proteins **[2 days]**

4. Qualitative/Quantitative estimation of lipids **[2 days]**

5. Qualitative/Quantitative estimation of of DNA **[2 days]**

6. Study of protein, DNA, RNA structures using (Pymol/Chimera) **[2 days]**

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	1	-	-	-	-	-	-	-	-	-
CO 2	1	2	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	2	1	-	-	-	-	-	-

Course Code	XBT1002			
Course Title	ORGANIC CHEMISTRY I			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	10+2 chemistry knowledge			

Learning Objective:

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications.

Course Outcomes:

Students will gain an understanding of:

CO 1: the hybridization and geometry of atoms and the three-dimensional structure of organic molecules

CO 2: the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry

CO 3: an understanding of nucleophiles, electrophiles, electronegativity, and resonance

CO 4: how to use their understanding of organic mechanisms to predict the outcome of reactions

Course Content:

Module I: Fundamental of Organic Chemistry (8L)

Classification, and nomenclature, hybridization, shapes of molecules, influence of hybridization on bond properties. Localized and delocalized bonds, inductive effect, field effect, electromeic effect, conjugation, resonance, hyper conjugation, steric assistance and steric inhibition of resonance, tautomerism. Dipole moment; Organic acids and bases; their relative strength. Formation, structure, stability and reactions of classical and non-classical carbocations, carbanions, carbenes, benzynes. Classification of reactions: substitution, elimination, addition, rearrangement.

Module II: Stereochemistry (10L)

Concept of constitution, stereochemical representation: Fischer, Newman, Sawhorse, Flying-wedge and their interconversions, molecular symmetry: plane, centre, simple and

alternating axes; symmetry operations, stereogenicity, Optical Activity, Specific Rotation, chirotopicity, achirotopicity; Axial chirality. Enantiomerism & Diastereoisomerism, Stereogenic centers involving C=C, C=N; D/L, R/S, E/Z, syn/ anti, cis/trans, meso/dl,threo/erythro nomenclature with CIP rules. Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Module III: Chemistry of Aliphatic Hydrocarbons (16L)

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity. Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cbreactions.Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration - demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to formcarbonyl compounds, Alkylation of terminal alkynes.

nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Module IV: Aromaticity and Aromatic Hydrocarbons (14L)

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions andheterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with theirmechanism. Directing effects of the groups. Preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Recommended Books

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).

3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry ofNatural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London,1994.

5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International,2005.

6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning IndiaEdition, 2013.

CO-PO Mapping:

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

Course Code	XBT1102			
Course Title	ORGANIC CHEMISTRY I LABORATORY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	3
Total Contact Hours	36			
Pre-requisites	10+2 chemistry knowledge			

Learning Objective:

Students will gain practical knowledge on various avenues of organic chemistry.

Course Outcomes:

Students will gain an understanding of:
CO 1: how to calculate a limiting reagent, yield, and percent yield
CO 2: how to maintain a detailed scientific notebook
CO 3: how to critically evaluate data collected to determine the identity, purity, and yield of products
CO 4: how to summarize findings in writing in a clear and concise manner
CO 5: how to use the scientific method to create, test, and evaluate a hypothesis

Suggested list of experiments:

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
a. Water, b. Alcohol, c. Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds
4. Effect of impurities on the melting point – mixed melting point of two unknown organiccompounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and morethan 100 °C by distillation and capillary method)
6. Chromatography
a. Separation of a mixture of two amino acids by ascending and horizontal paperchromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)
7. Detection of special elements (N, S, Cl) from Organic Compounds.

Any other experiment carried out in the class.

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

CO-PO Mapping:

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

Course Code				
Course Title	COMPUTER FUNDAMENTALS			
Category	INTERDISCIPLINARY COURSE			
LTP & Credits	L	T	P	Credits
	4	0	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:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	1	1	2	1	1	2	2	3	3	-	-	-
CO 2	1	1	2	1	-	2	2	3	3	-	-	-
CO 3	1	1	1	3	-	2	2	1	3	-	-	-
CO 4	2	1	1	1	1	-	-	3	2	2	-	-
CO 5	2	1	1	1	1	-	-	2	1	1	-	-

Course Code				
Course Title	BASIC ENGLISH			
Category	ABILITY ENHANCEMENT COURSE			
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 learners to communicate effectively and appropriately in real life situation and to use English for study purposes.

Course Outcome:

CO1: To understand the modalities and nuances of communication in a workplace context.

CO2: To understand the basics of English grammar.

CO3: To develop requisite skills for effective reading and comprehension of texts.

CO4: To learn to write English confidently without grammatical error(s).

Course Content:

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

Introduction; meaning of communication; five stages of communication; formal and informal communication; verbal and non-verbal communication; role of body language in communication; barriers to effective communication; prejudice and lack of sensitivity in communication; gender/culture neutrality

Module 2: Grammar [6L]

Subject and predicate; articles and prepositions; parts of speech; tense; sentences: simple, complex and compound; transformation of sentences.

Module 3: Comprehension [8L]

Reading comprehension; skimming and scanning; identifying main ideas; summarising; one-word substitution; synonyms and antonyms and sentence making.

Module 4: Writing Skills [6L]

Paragraph; formal and informal letters; job applications; dialogue writing.

Text/ Reference Books:

1. The Four Skills for Communication — Josh Sridharan — Foundation Books.

2. Communicative English – E. Suresh kumar and P. Srehari – Orient Blackswan

3. Speaking Effectively — Jeremy Comfort — Cambridge University Press

4. High School English Grammer and Composition – Wren and Martin

5. CVs and Job Applications – Judith Leigh – Oxford University Press

6. Technical English Writing, Reading and Speaking — Pickett, Laster and Staples – Longman.

CO/PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	3	-	-	2	3
CO 2	2	-	1	-	-	-	-	-		-	-	2
CO 3	2	-	-	-	-	-	-	3	-	-	-	2
CO 4	2	-	1	-	-	-	-	3	-	-	1	2

Course Code				
Course Title	INTELLECTUAL PROPERTY RIGHTS			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

To introduce fundamental aspects of Intellectual Property Rights to students who are going to play a major role in development and management of innovative projects in industries.

To disseminate knowledge on patents, patent regime in India and abroad and registration aspects.

To disseminate knowledge on copyrights and its related rights and registration aspects.

To disseminate knowledge on trademarks and registration aspects.

To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects.

Course outcome:

CO 1: The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works

CO 2: During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations

CO 3: Pave the way for the students to catch up Intellectual Property(IP) as career option-

R&D IP Counsel

Government Jobs – Patent Examiner

Private Jobs

Patent agent and Trademark agent
Entrepreneur

Course Content:

Module 1: Overview of Intellectual Property [8L]

Definition of Intellectual Property Right (IPR)
Need for Intellectual Property Rights
Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design
Sui Generis System
Geographical Indication, Plant Varieties and Layout Design
Genetic Resources and Traditional Knowledge
Trade Secret
Impact of IPR on Development, Health, Agriculture and Genetic Resources
IPR in India: Genesis and development
IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994

Module 2: Patents [6L]

Patents
Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), Industrial Application
Non - Patentable Subject Matter
Registration Procedure
Rights and Duties of Patentee
Assignment and Licence
Restoration of lapsed Patents
Surrender and Revocation of Patents
Infringement, Remedies & Penalties

Module 3: Copyrights [4L]

Nature of Copyright
Subject matter of Copyright: Original Literary, Dramatic, Musical, Artistic Works; Cinematograph Films and Sound Recordings
Registration Procedure
Term of Protection
Ownership of Copyright
Concept of Plagiarism
Assignment and Licence of Copyright
Infringement, Remedies & Penalties

Module 4: Trademarks [4L]

Concept of Trademarks
Different kinds of Marks (Brand Names, Logos, Signatures, Symbols, Well Known Marks, Certification Marks and Service Marks)
Non Registrable Trademarks
Registration of Trademarks

Rights of Holder and Assignment and Licensing of Marks
Infringement, Remedies & Penalties

Module 5: Other forms of IP **[10L]**

Industrial Design
Design: Meaning and Concept of Novel and Original
Procedure for Registration, Effect of Registration and Term of Protection

Geographical Indication (GI)
Geographical Indication: Meaning, Types and Difference between GI and Trademarks
Procedure for Registration, Effect of Registration and Term of Protection

Plant Variety Protection

Plant Variety Protection: Meaning and Benefit Sharing and Farmers' Rights
Procedure for Registration, Effect of Registration and Term of Protection

Layout Design Protection

Layout Design Protection: Meaning
Procedure for Registration, Effect of Registration and Term of Protection

Traditional Knowledge
Indigenous, Medicinal, Bioprospecting Knowledge Examples,
Need for Protection

Trade Secret
Trade Secrets Law, Determination of Trade Secret Status
Liability for Misappropriations of Trade Secrets, Protection for Submission

Module 6: Current Contour **[4L]**

India`s New National IP Policy, 2016

Govt. of India step towards promoting IPR

Govt. Schemes in IPR

Text / Reference Books:

1. Cornish W.R. Intellectual Property, Patents, Trade Marks, Copy Right and Allied Right, Asia Law House, Hyderabad.

2. Vikas Vashishth, Law and practice of Intellectual Property, Bharat Law House Delhi.

3. P. Narayanan, Inetellectua1 Property Law, (ed) Eastern Law House,Calcutta

4. Bibeck Debroy (ed). Intellectual Property Right, Rajiv Gandhi Foundation, Delhi

5. W.R. Cornish, Intellectual Property (3rd ed) Sweet and Maxwell

6. K. Thairani, copyright: The Indian Experience.

7. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

8. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf

2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub

_489.pdf

Reference Journal:

1. Journal of Intellectual Property Rights (JIPR): NISCAIR

CO-PO Mapping:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**
CO 1	1	1	2	1	1	2	2	3	3	-	-	-
CO 2	1	1	2	1	-	2	2	3	3	-	-	-
CO 3	1	1	1	3	-	2	2	1	3	-	-	-

Course Code				
Course Title	ENZYMOLOGY			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
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: [12L]

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: [6L]

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: [6L]

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: [12L]

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 in vitro & in vivo.

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	-	-	-	-	-	-	3
CO 2	3	-	2	-	-	-	-	-		-	-	3
CO 3	3	1	2	-	-	-	-	-	1	-	-	2
CO 4	3	2	2	-	-	-	-	-	2	-	1	2
CO 5	-	-	2	-	-	2	-	-	2	-	2	2

Course Code				
Course Title	MOLECULAR DIAGNOSTICS			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
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: [12L]

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: [9L]

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: [9L]

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: [6L]

GLC, HPLC, Electron microscopy, flow cytometry 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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	2	-	-	-	-	-	-	-	3
CO 2	2	3	-	-	2	-	-	-		-	-	2
CO 3	2	2	2	-	-	-	-	-	-	-	-	2
CO 4	2	-	1	-	2	-	-	-	-	1	2	2

Course Code				
Course Title	BIOFERTILIZERS AND BIOPESTICIDE			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
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 [10L]

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

Symbiotic N_2 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 [6L]

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

Module 3: Phosphate Solubilizers [6L]

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

Module 4: Mycorrhizal Biofertilizers [6L]

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

Module 5: Bioinsecticides [8L]

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	2	-	-	1	-	-	2
CO 2	3	-	2	-	-	-	-	-	-	-	-	3
CO 3	3	1	-	-	-	-	-	-	2	-	-	2
CO 4	3	2	-	-	-	-	-	-	-	2	1	2

Course Code				
Course Title	CONSTITUTIONAL LAW			
Category	VALUE ADDED COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Course Objective:
The objective is to understand the enforcement of fundamental rights, directive principles of state
policy and legal recourse open whenever the rights are infringed.

Course Outcome:
CO1 Students will learn about their fundamental rights enshrined under the Constitution.
CO2 Students will learn the policies enumerated to state for implementation according to Directive Principles of State Policy.
CO3 Students will learn about their fundamental duties and the punishable code through which the Indian citizen will be punished if they don't follow those.
CO4 Students will learn about constitutional remedies.

Module I: Introduction to the Constitution and Constitutional Law of India

Historical background to the Making of the Constitution of India
Preamble of the Constitution of India-

- ✓ 'Sovereign Socialist Secular'
- ✓ 'Democratic Republic'
- ✓ 'Separation of Powers'
- ✓ 'Rule of Law'

- Federalism: Meaning, Scope and Concepts
- Indian federal structure according to Indian Constitution.
- Separation of Powers- conceptual analysis, comparison with US model

Module II: Citizenship and Fundamental Rights (Art 12-35)

- Meaning of Citizenship
- Citizenship at the commencement of the constitution (Article 5,6,7)
- Citizenship under the Citizenship Act, 1955
- Origin and development of Fundamental Rights
- Widest interpretation of Provision of Part III
- Suspension of Fundamental Rights
- Definition of "State" (Article 12)
- Law inconsistent with Fundamental Rights (Article- 13)
- Doctrine of Severability – Doctrine of Eclipse – Doctrine of waiver
- Right to Equality (Article 14-18)
- Right to Freedom (Article 19-22)
- Protection of Life and Personal Liberty (Article 21)

- Right against Exploitation (Article 23-24)
- Right to Freedom of Religion (Article 25-28)
- Cultural and Educational Rights (Art 29-30)
- Right to Constitutional Remedies (Art 32-35)

Module III: Directive Principle of State Policy (Art 36-51) and Fundamental Duties (Article 51A)

Introduction; Objective of DPSP, Modes of DPSP, Relation between DPSP and FR, DPSP given status of FR, Fundamental Duties- An aid to Interpretation of constitutional Provisions

Module IV: The Three Wings of Government

- Legislature: Structure of Parliament and State Legislatures, Mode of Election, Parliamentary Procedures, Voting, Powers and Functions- (Article 79-122, 148-151)
- Executive: Structure of Union and State Governments, Cabinet, Powers and Functions of PM / CM (Article 52-78, 123)
- Judiciary: Structure of the Courts, Jurisdiction, Appointment of Judges, Supreme Court as the Final Interpreter of the Constitution, Powers and Functions (Article 124-147, 214-227)

Module V: Judiciary and its Independence (Art 124-147,214-227) and Executive and its Discretion (Article 52-78, 123)

- Independence of Judiciary: why so crucial?
- Transfer of Judges
- Judicial Review- HC powers of Superintendence u/A. 226., Supervision u/A. 227, Jurisdictions of the SC, Review and Curative Petition, Supreme Court as a Court of Record- Contempt Power
- President as the 'nominal head' of the Executive
- 'Aid and advice of the council of ministers'-Discretionary Powers of the President and Governors
- Powers of Pardon
- Legislative Power of the Executive

Module VI: Amendment to the Constitution and Basic Structure Doctrine and Emergency Provisions

- Understanding A. 368
- 'Procedure to Amend' to 'Power to Amend'
- Impact of 24^{th} and 25^{th} Amendments
- 42^{nd} Amendment and the A. 368
- Evolution of Basic Structure Doctrine
- Pre-Keshavananda Bharati
- Post-Keshavananda Bharati
  - ✓ Proclamation of Emergency under A. 352: Instances and Debates, Changes introduced by the 44^{th} Amendment

- ✓ President's Rule under A. 356: Instances and Debates, Judicial Review

Bare Acts:

- Constitution of India, 1950

Suggested Readings:

1. M.P.Jain, Indian Constitutional Law, Wadhwa & Co, Nagpur
2. V.N.Shukla, Constitution of India, Eastern Book Company, Lucknow
3. Granville Austin, Indian Constitution-Cornerstone of a Nation, OUP, New Delhi
4. H.M.Seervai, Constitutional Law of India (in 3 Volumes), N.M.Tripathi, Bombay
5. G.C.V.Subba Rao, Indian Constitutional Law, S.Gogia & Co., Hyderabad

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	2	-	-	1	-	-	2
CO 2	3	-	-	-	-	-	-	-	-	-	-	3
CO 3	3	-	-	-	-	-	-	-	2	-	-	2
CO 4	3	-	-	-	-	-	-	-	-	2	1	2

Course Code				
Course Title	PUBLIC HEALTH AWARENESS			
Category	VALUE ADDED COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objectives:

In-depth understanding of the key concepts, challenges, and strategies involved in promoting public health at the community and population levels. To explore various public health issues, the importance of health awareness, and effective communication techniques to promote health awareness and preventive measures.

Course Outcomes:

CO1: Understanding the concepts of public health principles, including disease prevention, health promotion, and the social determinants of health.

CO2: Developing communication skills to design and deliver public health messages to audiences.

CO3: Learning behaviour change theories and techniques to encourage positive health behaviours and lifestyle modifications within communities.

CO4: Assessing effectiveness of public health awareness initiatives through data collection and analysis, ensuring campaigns achieve their intended goals and outcomes.

Module I: Introduction to Public Health Awareness [12 L]

Understanding Public Health, Definition and scope of Public Health, Historical milestones and key figures in Public Health, The significance of Public Health in promoting population health; **Determinants of Health:** Social determinants of health and their impact on well-being, Behavioural and environmental determinants of health, Health

disparities and the role of Public Health in addressing them; **Strategies for Effective Health Communication:** Theories of health behaviour change, Identifying target audiences and cultural competence, Communication channels and platforms for public health campaigns, Designing impactful messages and storytelling techniques; **Planning and Evaluating Public Health Campaigns:** Steps in developing a public health awareness campaign, Setting measurable objectives and goals, Designing effective health promotion campaigns, Monitoring, measuring, and evaluating campaign success; **Health Promotion and Disease Prevention:** Health Promotion Theories and Models, Understanding behaviour change theories, Application of health promotion models in Public Health programs.

Module II: Introduction to Disease Emergence and Re-emergence [12 L]

Definition and distinction between disease emergence and re-emergence, Historical examples of notable emerging and re-emerging infectious diseases, Factors contributing to the spread of diseases in a globalized world; **Zoonotic Diseases and Spill over Events:** Understanding zoonotic diseases and their origins in animal populations, Drivers of zoonotic spill over events to human populations; **Environmental Factors and Disease Spread:** Impact of environmental changes on disease emergence, Climate change, deforestation, and disease transmission, **Identifying environmental health hazards:** Bio aerosols, Air borne microorganisms (Bacteria, Viruses, Fungi) and their impact on human health and environment; **Antimicrobial Resistance (AMR):** Overview of antimicrobial resistance and its implications for disease control, Factors contributing to the development and spread of AMR, Public health strategies to combat antimicrobial resistance; **One Health Approach:** Understanding the One Health concept and its significance in disease control, Collaboration between human, animal, and environmental health sectors, Case studies exemplifying successful One Health initiatives.

Module III: Public Health Challenges and Solutions [12 L]

Infectious Disease Control, Overview of infectious diseases and their transmission, Outbreak investigation and response, Vaccination programs and their role in preventing infectious diseases; **Non-Communicable Diseases (NCDs):** Understanding the burden of NCDs**,** Risk factors and prevention strategies for NCDs**,** Public Health policies to

address NCDs**; Maternal and Child Health:** Maternal and child health indicators and disparities**,** Prenatal care and maternal well-being**,** Child development and early interventions**; Mental Health Awareness:** Prevalence and impact of mental health disorders**,** Promoting mental health and well-being**,** Reducing stigma surrounding mental health; **Preventive Strategies and Interventions**: Screening programs and their importance in disease prevention, Immunization and herd immunity, Lifestyle modifications for disease prevention.

Text / Reference Books:

1. Introduction to Public Health, 4th Edition. Elizabeth Parker, Ignacio Correa-Velez, and Mary Louise Fleming.
2. Community Public Health in Policy and Practice, 3rd Edition. Edited by Sarah Cowley, and Karen Whittaker.
3. Disease Mapping and Risk Assessment for Public Health. Andrew B. Lawson, Annibale Biggeri Dankmar Böhning, Emmanuel Lesaffre.
4. A Textbook of Health Awareness. M.F. Khan.
5. The New Public Health, 3rd Edition, Theodore H. Tulchinsky, Elena A. Varavikova.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	3	-	1	-	1	-	2
CO 2	3	-	2	-	-	1	1	-	-	-	1	2
CO 3	3	-	2	-	-	1	1	1	-	-	-	2
CO 4	3	-	1	-	-	2	-	1	-	-	-	2

Detail Syllabus B.Sc. Biotechnology Semester-2

SEMESTER-2								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT2001	Metabolism	4	0	0	4	4
2	MINOR	XBT2002	Organic Chemistry II	4	0	0	4	4
3	IDC		Fundamentals of Physics	4	0	0	4	4
4	AEC		English Advance	2	0	0	2	2
5	SEC		SECV/VI/VII/VIII	3	0	0	3	3
6	VAC		Environmental science/ Ethnomedicine/ Mushroom Culture	3	0	0	3	3
PRACTICAL								
7	MAJOR PRACTICAL	XBT2101	Biochemistry II Laboratory	0	0	3	2	3
8	MINOR PRACTICAL	XBT2102	Organic Chemistry II Laboratory	0	0	3	3	3
	TOTAL			**20**	**0**	**6**	**25**	**26**

Course Code	XBT2001			
Course Title	METABOLISM			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of biomolecules			

Learning Objective:

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

Course Outcome:

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

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

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

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

Course Content:

Module 1: Carbohydrate metabolism [12L]

Glycolysis: Overview, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, energetics of glycolysis, cori cycle, galactosemia, regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance, glycogenesis glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Citric acid cycle: Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Module 2: Fatty acid metabolism [12L]

Digestion, mobilisation and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone body's metabolism, ketoacidosis. Fatty acid synthase complex.

Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation. Eicosanoids, cholesterol, steroids and isoprenoids

Module 3: Amino Acid and Nucleic Acid Metabolism [12L]

Overview of metabolism, amino acid deamination, urea cycle, metabolic breakdown of amino acids, amino acid synthesis, amino acids of biosynthetic precursors, biochemistry of nitrogen fixation, Overview, synthesis of Purine and Pyrimidine Ribonucleotides, Formation of deoxyribonucleotides, nucleotide degradation, biosynthesis of nucleotide coenzymes, disorders of purine and pyrimidine metabolism –Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

Module 4: Electron Transport Chain & Oxidative phosphorylation [12L]

Mitochondria, Electron transport chain (ETC), Q cycle, Oxidation, reduction reactions, inhibitors of ETC, uncouplers, chemiosmotic hypothesis, proton motive force, structure and function of F_oF_1 ATP synthase, mechanism of ATP synthesis, ATP-ADP translocase, malate-aspartate shuttle, glycerol-3-phosphate shuttle regulat,ion of oxidative phosphorylation, ROS production and antioxidant mechanisms.

Text / Reference Books:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
2. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
3. Lehninger Principles of biochemistry, Nelson and Cox, W.H.Freeman and Company

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XBT2101			
Course Title	BIOCHEMISTRY II LABORATORY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	Basic knowledge of biomolecules			

Learning Objective:

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

Course Outcome:

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

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

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

Suggestive List of Experiments:

1. Validation of Beer-Lambert Law **[2 days]**
2. Analysis of lipid by TLC **[2 days]**
3. Analysis of amino acids by TLC **[2 days]**
4. Enzymatic assay of salivary amylase (effect of pH, temperature) **[2 days]**
5. Enzymatic assay (determination of K_m and V_{max}) **[2 days]**
6. SDS PAGE **[2 days]**

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	1	-	-	-	-	-	-	-	-	-
CO 2	1	2	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	2	1	-	-	-	-	-	-

Course Code	XBT2002			
Course Title	ORGANIC CHEMISTRY II			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Knowledge of Chemistry up to 12 th standard.			

Course Objective:

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications.

Course Outcomes:

CO1: Able to describe the fundamental properties of atoms & molecules, atomic structure and periodic properties and acid-bases concepts.

CO2: Able to apply fundamental concepts of thermodynamics, electrochemistry in different engineering applications.

CO3: Develop the knowledge of modern organic chemistry in different engineering applications.

CO4: Able to apply the knowledge of water quality parameters, corrosion control & polymers to different industries and Design economically and new methods of synthesis nano materials.

CO5: Able to determine the structure of organic molecules using different spectroscopic techniques.

Course Content:

Module I: Nitrogen Containing Functional Groups (10L)

Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2°and 3°amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

Module II: Alcohols, Phenols, Ethers and Epoxides (12L)

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-BlancReduction; Preparation and properties of glycols: Oxidation by periodic acid and leadtetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitutionreactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisenrearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides withalcohols, ammonia derivatives and LiAlH4.

Module III: Carbonyl Compounds (14L)

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4,$NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Module IV: Carboxylic Acids and their Derivatives (12L)

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.

Recommended Books

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

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

CO-PO Mapping:

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

Course Code	XBT2102			
Course Title	ORGANIC CHEMISTRY II LABORATORY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	3
Total Contact Hours	36			
Pre-requisites	Knowledge of Chemistry up to 12 th standard.			

Learning objective:

To impart scientific approach and to familiarize with the experiments in chemistry relevant and to Provide the students with a solid foundation in Chemistry laboratory required to solve biotechnological problems and practical implementation of fundamental concepts

Course Outcomes:

Students will gain an understanding of:

CO 1: how to perform common laboratory techniques, including reflux, distillation, steam distillation, recrystallization, vacuum filtration, aqueous extraction, thin layer chromatography, column chromatography

CO 2: how to predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups

Suggested list of experiments:

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.

2. Organic Preparations:

i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*toluidinesand *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylicacid) by any one method:

a. Using conventional method.

b. Using green approach

ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-,*m*-, *p*-anisidine) and one of the following phenols (β-naphthol, resorcinol, pcresol)by Schotten-Baumann reaction.

iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).

iv. Bromination of any one of the following:a. Acetanilide by conventional methods, b. Acetanilide using green approach (Bromate-bromide method)

v. Nitration of any one of the following:a. Acetanilide/nitrobenzene by conventional method, b. Salicylic acid by green approach (using ceric ammonium nitrate).

vi. Selective reduction of *meta*dinitrobenzene to *m*-nitroaniline.

vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

viii. Hydrolysis of amides and esters.

Reference Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009)

2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.* Pearson (2012)

3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).

CO-PO Mapping:

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

Course Code				
Course Title	FUNDAMENTALS OF PHYSICS			
Category	INTERDISCIPLINARY COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	10+2 physics knowledge			

Learning objectives:

This course offers a through introduction to the concept and techniques of Physics along with the possible applications in bioscience. Problem solving and quantitative reasoning are emphasized.

Course Outcome:

CO1: Able to update their knowledge about the basic principle of Newtonian mechanics and apply the knowledge of flow of liquid and surface tension on liquid surface.

CO2: Able to analyze differential equations of electrostate and magnetostate, scalar and vector potential, electric and magnetic fields and also understand the laws of thermodynamics.

CO3: Able to explain the electronic structure in atoms using different spectra.

CO4: Able to understand the various lasers systems and their applications.

Course Content:

Module 1: [14L]
Mechanics: Representation of vector, scalar and vector fields, partial derivative of vector, gradient of scalar field, divergence and curl of vector field**,** Newton's Law, Central force, Two body Collisions, Rigid Body, Moment of Inertia
Properties of Matter: Surface tension, eleasticity, viscosity, adsorption, diffusion. Fluids: Definition, Pressure and Density. Pascal's Principle. Measurement of pressure.

Module 2: [16L]
Electrostate and Magnetism: Electric charge and fields, electric potential, electric dipole, Gauss law, capacitors, electrostatic energy. The magnetic fields, The definition of B. Gauss' law of magnetism. Magnetic flux, Faraday's law of electromagnetic induction, electromotive force, Ampere's circuital law, Maxwell's equation. magnetic permeability, magnetic susceptibility, classification of magnetic materials, Magnetism of earth. Paramagnetism. Diamagnetism. Ferromagnetism.
Thermodynamics: laws of thermodynamics and their consequences, activation energy, systems as open, non-equilibrium systems, Concept of free energy, unavailable energy and entropy, Enthalpy, Negative entropy as applicable to biological systems, thermodynamic potential.

Module 3: **[8L]**

Atomic structure: Historical background up to Bohr model. Significance of second and third postulate of Bohr's model. Quantization of energy levels using Rydburg's constant, Bohr – Sommerfeld model. Quantum numbers, Pauli's exclusion principle, Constituents of atomic nuclei, Isotopes, Isobars, Isotones, Isomers,

Module 4: **[10L]**

Wave optics: Reflection and refraction of plane waves, Interference, Diffraction, Polarization, and Young's experiment

Laser and Applications: Physical aspects of medical imaging, LASER beam in biology & medicine, Fundamentals of laser physics, Medical lasers (Carbon Dioxide Laser, Nd:YAG Laser,),Applications of Lasers in therapy and diagnosis

Optical Fiber: Principles – Physical, structure and types – Optical fibre communication

Text Books/References:

1. A.B. Gupta, mechanics and properties of matter 5th edition, Publisher: Books & Allied (P) Ltd (2021)
2. B. Ghosh, Foundation of Electricity and Magnetism, Publisher: Books & Allied (P) Ltd (2008)
3. Mathew N.O. Sadiku (SAD), Elements of Electromagnetics, Oxford University Press (2001)
4. S.C. Garg, R.M. Bansal, C.K. Ghosh, Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, 2nd Edition, Mcgraw Hill education (2017)
5. A. B. Gupta, Modern Atomic and Nuclear, Physics Books & Allied (P) Ltd (2009)
6. S.N. Ghoshal, Atomic Physics (modern Physics), S. Chand (2010)
7. A. Ghatak(AG), Optics, 3rd Edition, Tata Mcgraw Hill (2005)
8. A.B. Bhattacharya and R. Bhattacharya, Under graduate Physics, Vol I, , NCBA (2010)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	3	-	-	-	-	-	-	-	-	3
CO 2	3	3	3	-	1	-	-	-	-	-	-	3
CO 3	2	-	-	-	-	-	-	-		-	-	2
CO 4	3	3	3	3	2	-	-	-	-	-	-	3

Course Code				
Course Title	ENGLISH ADVANCE			
Category	ABILITY ENHANCEMENT COURSE			
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 for study purposes.

Course Outcome

CO1: To understand the fundamentals of group discussion and to be able to speak with confidence at job interviews.

CO2: To impart basic English grammer and essentials of important language skills.

CO3: To acquire a working knowledge of writing strategies, formats and templates of professional writing.

CO4: To develop critical comprehension reading strategies and to enhance English vocabulary. Course Content

Course content:

Module 1: Professional Interaction (6L)

Definition, relevance and purpose of group discussion; strategies for an effective GD; mechanism and formats of GD; types of and preparations for job interview; evaluation of performance; myths about job interviews.

Module 2: Grammer (5L)

Voice change; direct and indirect speech; words often confused and misused; common grammatical errors; phrasal verbs and idioms.

Module 3: Writing Skills (5L)

Essay; CV/Resume writing; Technical Report Writing; minutes of meeting; importance of punctuation in writing

Module 4: Vocabulary and Reading (8L)

Reading comprehension; fictional and non-fictional prose; note taking and note making.

1. “Ode to a Nightingale” by John Keats.

2. “Introduction” by Kamala Das

3. “The Last Leaf” by O Henry

4. “Shooting an Elephant” by George Orwell

Text/ Reference Books:

1. Speaking Effectively— Jeremy Comfort— Cambridge University Press.

2. Mastering Interviews and Group Discussions — Dinesh Mathur – CBS Publications.

3. English Grammer in Use – Raymond Murphy – Cambridge University Press.

4. Study Writing – Ben Heasley and Liz Hamp-Lyons – Cambridge University Press.

5. Practical English Usage – Michael Swan – Oxford University Press.

6. CVs and Job Applications – Judith Leigh – Oxford University Press

CO/PO Mapping

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	3	-	-	2	3
CO 2	2	-	1	-	-	-	-	-		-	-	2
CO 3	2	-	-	-	-	-	-	3	-	-	-	2
CO 4	2	-	1	-	-	-	-	3	-	-	1	2

Course Code				
Course Title	STRUCTURAL BIOINFORMATICS			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

The course aims to provide an advanced understanding of the core principles and topics of structural bioinformatics and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of macromolecular structure, homology modelling, structure analysis etc.

Course Outcome:

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

CO2: Develop a documented understanding of the protein structure, function by participating in class discussions, and completing quizzes and exams.

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

CO4: Inquisitiveness to find application of in drug designing and vaccine development.

Course Content:

Module 1: Protein structure [12L]

Introduction to protein structure – amino acids, peptide bond, dihedral angle, primary, secondary, tertiary and quaternary structure; Folds and motifs; brief introduction of protein folding pathways and energy landscape; protein diversity; multi-protein complexes; protein – ligand complex; protein – nucleic acid complex; structure and function relation: conformational dynamics and catalytic mechanism (spring loaded mechanism); different methods to determine structure – X ray Crystallography, Cryo-Electron Microscopy, NMR.

Module 2: Protein structure visualization and analysis [12L]

Protein structure databases; visualization of protein structure; analysis of protein structure; protein structure comparison; protein structure classification; protein structure prediction; visualization and analysis of protein – protein interaction interface;

visualization of protein – ligand interaction protein; determining the contribution of H bond and hydrophobic interaction in ligand binding; homology modelling; threading and fold recognition; Ab initio structure prediction.

Module 3: Nucleic Acid / Nucleic Acid-protein structure and applications of structural bioinformatics: [12L]

Visualization of DNA and RNA structure; different types of RNA structure; RNA structure prediction; visualization and analysis of protein – nucleic interaction and determining the contribution of H bond and hydrophobic interaction; basic introduction to molecular docking, structure guided drug designing, brute force screening, rational drug designing; brief introduction of molecular dynamics simulation workflow, result analysis and visualization of a sample trajectory using standard viewing tool.

Text / Reference Books:

1. Jin Xiong; Essential Bioinformatics, Cambridge University Press

2. Carl Ivar Branden, John Tooze; Introduction to protein structure; Garland Science

3. Alan Fersht; Structure and mechanism in protein science a guide to enzyme

catalysis and protein folding; W.H.Freeman and Company

4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and

Company

5. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	1	-	-	-	-	-	-	-
CO 4	1	1	2	2	2							

Course Code				
Course Title	FERMENTATION TECHNOLOGY			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
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: **[8L]**

Application of microorganisms for the industrial production of chemicals, biochemicals and chemotherapeutants: Citric acid, Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, Microbial polysaccharides; Microbial insecticides; Food additives. Drugs: anti-microbial, anti-cancer, anti-fungal. Biopolymers: Pectin, Bioplastic.

Module 2: **[10L]**

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: **[8L]**

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: [10L]

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	-	-	-	-	-	-	3
CO 2	3	1	2	-	-	-	-	-		-	-	3
CO 3	3	-	2	1	-	-	-	-	-	-	1	2
CO 4	3	2	2	-	-	-	-	-	1	-	-	2

Course Code				
Course Title	BASICS OF FORENSIC SCIENCE			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
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: **[10L]**

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: **[10L]**

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: **[8L]**

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: **[8L]**

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	-	-	-	-	-	-	3
CO 2	3	1	2	-	-	-	-	-		-	-	3

Course Code				
Course Title	ANIMAL BIOTECHNOLOGY			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
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 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: **[8L]**

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: **[10L]**

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

Module 4: **[8L]**

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	3	-	-	-	2	-	-	2	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	3
CO 3	3	2	1	-	-	-	-	-	-	-	-	2
CO 4	2	2	-	-	-	-	-	-	-	-	-	2

Course Code				
Course Title	ENVIRONMENTAL SCIENCE			
Category	VALUE ADDED COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
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 [10L]

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 and Man-made), Floods, Earthquake, Tsunamis, Cyclones, landslides (cause, effect and control)

1.4 Ecology and Ecosystem: Elements of ecology, definition of ecosystem- components types and function, Food chain and 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 [10L]

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

2.2 Types of air pollutants: primary and 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 and climate: Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion

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

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

Module 3: Water Pollution [8L]

3.1 Classification of water (Ground and 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 and 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 [4L]

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 [4L]

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**
CO 1	3	2	2	-	-	-	-	-	-	-	-	3
CO 2	2	-	1	-	-	3	-	-	2	-	-	2
CO 3	2	-	-	-	-	2	-	3	-	-	-	2
CO 4	-	-	2	-	-	2	-	-	2	-	-	2

Course Code				
Course Title	ETHNOMEDICINE			
Category	VALUE ADDED COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

To gather knowledge about ethno medicinal properties of natural products and their uses in ancient time as well as in future.

Course outcome:

CO 1: Able to express the historical development of ethno medicinal values of natural products.

CO 2: Able to recognize and identify important plant species with ethno medicinal properties.

CO 3: Able to explain ethno botanically uses of plants. Detail their native habitats and cultivated lands.

Course content:

Module 1: [6L]

Ethnomedicine – definition, history and its scope – Inter disciplinary approaches in ethnobotany – Collection of ethnic information.

Module 2: [6L]

Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).

Module 3: [8L]

Tribal medicine – methods of disease diagnosis and treatment – Plants in folk religion – Aegle marmelos, Ficus benghalensis, Curcuma domestica, Cyanodon dactylon and Sesamum indicum.

Module 4: [10L]

Traditional knowledge and utility of some medicinal plants– Solanum trilobatum, Cardiospermum halicacabum, Vitex negundo, Adathoda vasica, Azadirachta indica, Gloriosa superba, Eclipta alba, Aristolochia indica, Phyllanthus fraternus and Boerhaavia diffusa.

Module 5: [6L]

Plants in day today life – Ocimum sanctum, Centella asiatica, Solanum trilobatum, Cassia auriculata, Aloe vera. Nutritive and medicinal value of some fruits (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate) and vegetables - Greens (Moringa, Solanum nigrum) Cabbage.

Text / Reference Books:

1. Ethnobiology – R.K.Sinha & Shweta Sinha – 2001. Surabhe Publications – Jaipur.

2. Tribal medicine – D.C. Pal & S.K. Jain 1998, Naya Prakash, 206, Bidhan Sarani, Calcutta – 700 006.

3. Contribution to Indian ethnobotany – S.K. Jain 1995, 3rd edition, Scientific publishers, P.B.No. 91, Jodhpur, India.

4. A Manual of Ethnobotany – S.K.Jain, 1995, 2nd edition.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	-	-	-	-	-	-	-	-	3
CO 2	2	-	1	-	-	3	-	-	2	-	-	2
CO 3	2	-	-	-	-	2	-	3	-	-	-	2

Course Code				
Course Title	MUSHROOM CULTURE			
Category	VALUE ADDED COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning objectives:

Enable the students to identify edible and poisonous mushrooms

Provide hands on training for the preparation of bed for mushroom cultivation and spawn production

Give the students exposure to the experiences of experts and functioning mushroom farms

Help the students to learn a means of self-employment and income generation

Course outcome:

By successfully completing the course, students will be able to:

CO1: Identify edible types of mushroom

CO2: Gain the knowledge of cultivation of different types of edible mushrooms and spawn production

CO3: Manage the diseases and pests of mushrooms

CO4: Learn a means of self-employment and income generation

Course content:

Module 1: Introduction to mushrooms (8 hours)

Mushrooms -Taxonomical rank -History and Scope of mushroom cultivation - Edible and poisonous Mushrooms-Vegetative characters; Common edible mushroom: Button mushroom (Agaricus bisporus), Milky mushroom (Calocybe indica), Oyster (Pleurotus sajorcaju) and paddy straw mushroom (Volvariella volvcea); Medicinal mushrooms.

Module 2: Mushroom cultivation techniques (8 Hours)

Mushroom Farm design and layout, Sterilization of substrates, casting material, Spawn production and preparation, production of pure culture, mother spawn and multiplication of spawn. Principle and method of Composting, mushroom bed preparation. Spawning, spawn running, harvesting. Cultivation of oyster and paddy straw

mushroom. Problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies. Health benefits of mushroom: Nutritional and medicinal properties of mushrooms. Therapeutic aspects- antitumor effect.

Module 3: Post harvest technology (4 Hours)

Preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and

entrepreneurship. Value added products of mushrooms.

Module 4: Training/ Workshop/ Field visit (12 Hours)

Sterilization and sanitation of mushroom house, instruments and substrates. Preparation of mother culture, media preparation, inoculation, incubation and spawn production. Cultivation of oyster mushroom using paddy straw/agricultural wastes

References and Text books

1. Mushroom Cultivation, Tripathi, D.P.(2005) Oxford & IBH Publishing Co. PVT.LTD, New Delhi.

2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

3. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology.

Agrobios, Jodhpur.

4.Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

5. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New

Delhi.

6. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing

Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	1	-	-	-	-	-	-	-	2
CO 2	2	3	2	1	2	-	-	-	2	-	-	2

CO 3	2	2	2	1	-	3	-	-	2	-	-	2
CO 4	2	-	-	-	-	-	2	-	1	1	1	2

Detail Syllabus B.Sc. Biotechnology Semester-3

SEMESTER-3								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT3001	Cell Biology	4	0	0	4	4
2	MINOR	XBT3002	Physical Chemistry	4	0	0	4	4
3	IDC		Biomathematics and Biostatistics	4	0	0	4	4
4	AEC		Entrepreneurship Development	2	0	0	2	2
5	SEC		SEC IX/X	3	0	0	3	3
PRACTICAL								
7	MAJOR PRACTICAL	XBT3101	Cell Biology Laboratory	0	0	3	2	3
8	MINOR PRACTICAL	XBT3102	Physical Chemistry Laboratory	0	0	3	2	3
	TOTAL			**17**	**0**	**6**	**21**	**23**

Course Code	XBT3001			
Course Title	CELL BIOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	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: [6L]

History of cell biology, cell as basic unit of life, cell theory, protoplasm theory and organismal theory, Broad classification of cell types, Bacteria, Archaea (prokaryotic) and eukaryotic cells and their similarities and dissimilarities.

Microscopy: Working principle, types and applications

Module 2: [8L]

Structure and functions of cell wall: Comparative analysis of bacterial cell wall plant cell wall and fungal cell wall. Plasma membrane – Basic structure and functions - exocytosis, endocytosis, phagocytosis, vesicles and their importance in transport. Cell Membrane and Permeability- Chemical components of biological membranes, organization and Fluid Mosaic Model.

Cytoskeleton structure – microtubules, microfilaments, intermediate filament - Structure, function and comparative analysis.

Module 3: [12L]

Structure and functions of cell organelles – endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), golgi apparatus, Mitochondria –

organization of respiratory chain, chloroplasts – photophosphorylation, nucleus, nucleolus, nuclear membrane and organization of chromosomes lysosomes, microbodies (peroxysomes and glyoxysomes), vacuoles, ribosomes, centriole and basal bodies.

Module 4: **[10L]**

Cell cycle and its check points, cell division (mitosis and meiosis). Apoptosis, Necrosis and Autophagy.

Cancer: Overview- Types- concept of proto-oncogene and tumor suppressor gene- Causes

Module 5: **[12L]**

Cell communication – overview – types of cell signaling – signal molecules – signal amplification – types of receptors.

Concept of quorum sensing in bacteria- regulation of cellular activity by second messenger system. Bacterial Biofilm and social behaviour.

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	-	-	-	-	-	-	2
CO 2	2	1	1	-	-	-	-	-	-	-	-	2
CO 3	1	-	-	2	2	-	-	-	-	-	-	2
CO 4	3	-	1	-	2	-	-	-	-	-	-	-
CO 5	3	-	1	-	-	-	-	-	-	-	-	2

Course Code	XBT3101			
Course Title	CELL BIOLOGY LABORATORY			
Category	MAJOR 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 of plasmolysis and de-plasmolysis. **[1 day]**

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

3. Mitosis and Meiosis study in eukaryotic cells. **[2 days]**

4. Cell Counting and viability study by hemocytometer. **[1 day]**

5. Blood Smear Preparation **[1 day]**

6. Mitochondria isolation **[1day]**

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	-	-	3	-	-	-	-	-	-	-	-	2
CO 2	-	-	3	1	-	-	-	-	-	-	-	2
CO 3	2	-	2	2	-	-	-	-	-	-	-	2

Course Code	XBT3002			
Course Title	PHYSICAL CHEMISTRY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	10+2 chemistry knowledge			

Learning objective:

To empower students with basic and applied knowledge of physical chemistry.

Course outcome:

Students will gain an understanding of:

CO 1: concepts in thermodynamics, different thermodynamic quantities such as heat and work and how they are measured, related or transformed from one to the other

CO 2: chemical equilibrium and its relationship with thermodynamic quantities

CO 3: the transport of ions and thermodynamic functions with applications to electron transfer in biological systems

CO 4: chemical kinetics; how reaction rates are measured and represented in rate laws, and applications of chemical kinetics in studying enzyme mechanisms

Course content:

Module I: Real gases, Thermodynamics and Viscosity: (16L)

Deviations from ideal behavior vander Waal's equation. Andrews exprement, critical phenomena in light in Vander wall's equation state, community of state.

First law of thermodynamics: Cyclic process, Reversible & irreversible process , internal energy, enthalpy, work done an isothermal & adiabatic pricess, heat capacities, Cp-Cv =R for an ideal gas.

Second law of thermodynamics: Carnot cycle, Elementary treatment of entropy, free entry, work function & criterion of equilibrium. Gibbs Helmohltz equation, Clasious clapeyron equation and its application.

Viscosity: Definition & determination of Oswald's viscomers, variation with temperature for liquid and gases.

Module II: Chemical equilibrium and Ionic Equilibrium and solutions: (12L)

Law of mass action and equilibrium constant Kp, Kc, Kx and their relationship. Le-chatelier principal- effect of temperature, pressure and addition of products of relation and inert gases. Vant's hoff equation (derivation not required) and its application. Strong and weak electrolytes degree of dissociation. Ostwald's dilution law. Hydrolysis, buffer,

calculation of pH, salt effect, elementary, elementary idea of activity & activity co-efficient of electrolytes, ionic strength, buffer reaction of blood. Rault's law, ideal solution, non-ideal solution, and qualitative treatment of colligative properties relative lowering of vapour pressure, elevation of boiling point, and osmotic pressure-their application in finding molecular weight. Van't Hoff 'i' factor, plasmolysis, haemolysis, isotonic solution, normal saline, role of osmosis in living organism.

Module III: EMF: (10L)

Electro chemical cells, half-cell, electrodes potential standard electrode potential, Nernst equation, redox potential, reference electrode, standered cell, measurement of emf, determination of pH, potentiometric titration, storage battery, corrosion.

Module IV: Chemicals Kinetics: (10L)

Rate, order and molecularity of a reaction, rate constants of first and second order reactions, half-life period, influence of temperature on reaction rate, activation energy, determination of order of a reaction. Homogeneous catalysis: Criterion of catalysis, mechanism of catalytic action, enzyme catalysis, industrial catalyst.

Recommended Books

1. Samuel Glasstone, An Introduction To Electrochemistry, Affiliated East-West Press Pvt. Ltd.New Delhi (2000)
2. J. O'M. Bockris, A. K. N. Reddy, Modern Electrochemistry, Vol. 2 A & B, 2nd Edition,Plenum Press, New York (1998)
3. P. W. Atkins, & J. de Paula, Physical Chemistry 8th Ed., Oxford University Press (2006).
4. G. W. Castellan, Physical Chemistry 4th Ed. Narosa (2004).
5. P.C. Rakshit, Physical Chemistry 7th Ed. Sarat book distributors, Calcutta (2001)
6. K. L. Kapoor, A Textbook of Physical Chemistry

CO-PO Mapping:

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

Course Code	XBT3102			
Course Title	PHYSICAL CHEMISTRY LABORATORY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	10+2 chemistry knowledge			

Learning objective:

Hands on training on surface tension, viscosity, Ph, diffraction pattern.

Course outcome:

CO1: Will be able to study the theories of common physical chemistry experiments

CO2: Will be able to prepare the solutions for the experiment

CO3: Will be able to perform the experiment and record the data in tabular form

CO4: Will be able to analyze the results and plot of graphs UNIT-V present the principles, methodologies, observations and calculation in the laboratory notebook in a scientific manner

Suggested list of experiments:

1. Surface Tension Measurements

a. Determine the surface tension by (i) drop number (ii) drop weight method

b. Study the variation of surface tension of detergent solutions with concentration

2. Viscosity Measurement using Ostwald's Viscometer

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.

b. Study the variation of viscosity of sucrose solution with the concentration ofsolute

3. Indexing of a given powder diffraction pattern of a cubic crystalline system

4. pH-metry

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid,sodium acetate and their mixtures

b. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base

d. Determination of dissociation constant of a weak acid

Any other experiment carried out in the class.

Recommended Books

1. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS

2. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry

3. G. N. Mukherjee, Handbook of Practical Chemistry

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

5. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York (2003).

6. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H.Freeman & Co.: New York (2003).

CO-PO Mapping:

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

Course Code				
Course Title	BIOMATHEMATICS AND BIOSTATISTICS			
Category	INTERDISCIPLINARY COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	10+2 mathematics knowledge			

Learning Objective(s):

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.

Course Content:

Module 1: Basic Probability [5L]

Random Experiment, Outcome, Event, mutually exclusive events, Equality like and exhaustive, Classical definition of probability, conditional probability, and statistical independence. Sequential definition of probability. Baye's theorem and related problems.

Module 2: Random Variable and Distribution [15L]

Discrete and continuous random variable, Probability density function and probability mass function for single variable only, Distribution function and its properties, Definitions of Expectation and Variance, properties and examples, Some important discrete distribution: Binomial and Poisson distribution and related problems. Some important continuous distribution: Normal and Uniform distributions and related problems.

Module 3: Basic Statistics [14L]

Elements of Statistical methods. Primary data and secondary data. Population and sample. Sample survey. Chart and diagram. Frequency distribution. Measures of central tendency: Mean,

Median, Mode, Measure of dispersion: Range, standard deviation, Measure of skewness and kurtosis, Correlation, regression lines and Curve fitting by the method of least squares: fitting of straight lines.

Module 4: Applied Statistics [14L]

Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM), Testing of hypothesis: large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations. Small samples Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Text/Reference Book:

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

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

Course Code				
Course Title	ENTREPRENEURSHIP DEVELOPMENT			
Category	ABILITY ENHANCEMENT COURSE			
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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	-	2	-	-	-	-	-	-	-	-	2
CO 2	-	-	-	-	-	-	-	2	-	-	2	-
CO 3	-	-	3	-	-	-	-	1	-	-	2	-
CO 4	1	-	-	-	2	-	-	2	-	-	2	-

Course Code				
Course Title	MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	Basic knowledge of microbiology			

Learning Objective:

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

Course Outcome:

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

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

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

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

Course Content:

Module 1: Microbiological Laboratory and Safe Practices [8L]

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

Module 2: Determining Microbes in Food / Pharmaceutical Samples [10L]

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

Module 3: Pathogenic Microorganisms of Importance in Food & Water [10L]

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

Module 4: HACCP for Food Safety and Microbial Standards [8L]

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

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	2	1	-	-	1	-
CO 3	-	2	2	1	1	1	-	-	-	-	-	-
CO 4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code				
Course Title	MANAGEMENT OF HUMAN MICROBIAL DISEASES			
Category	SKILL ENHANCEMENT COURSE			
LTP & Credits	L	T	P	Credits
	3	0	0	3
Total Contact Hours	36			
Pre-requisites	None			

Learning Objective:

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

Course Outcome:

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

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

CO3: Learning about therapeutic strategies used to treat these diseases

Course Content:

Module 1: Human Diseases [8L]

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

Module 2: Microbial diseases [10L]

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

Module 3: Therapeutics of Microbial diseases [10L]

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

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

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

Module 4: Prevention of Microbial Diseases [8L]

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

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	1	-	-	-	-	-	-	-

Detail Syllabus B.Sc. Biotechnology Semester-4

SEMESTER-4								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT4001	Microbiology	4	0	0	4	4
2	MAJOR	XBT4002	Molecular Biology	4	0	0	4	4
3	MINOR	XBT4003	Inorganic Chemistry	4	0	0	4	4
4	AEC		Values and Ethics	2	0	0	2	2
PRACTICAL								
5	MAJOR PRACTICAL	XBT4101	Cell Biology Laboratory	0	0	3	2	3
6	MAJOR PRACTICAL	XBT4102	Molecular Biology Laboratory	0	0	3	2	3
7	MINOR PRACTICAL	XBT4103	Inorganic Chemistry Laboratory	0	0	3	2	3
	TOTAL			**14**	**0**	**9**	**20**	**23**

Course Code	XBT4001			
Course Title	MICROBIOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:

This course deals with characteristics, properties and biological significance of the microbes. In depth knowledge of the 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 groups of bacteria.

CO3: Able to gain knowledge of various Culture media, growth conditions.

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

CO5: To understand how to handle microorganisms in appropriate biosafety levels and to maintain sterility in the laboratory.

Course Content:

Module 1: [8L]

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms:

Microbial taxonomy, criteria used to include molecular approaches, Microbial phylogeny; current approaches for bacterial classification.

Effect of Environment on Microbial Growth

Nutrient uptake and Transport

Aerobic and Anaerobic Respiration

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells,

Module 2: [10L]

General structure and characteristics and nature of Archaebacteria, Eubacteria, Protozoa, Algae, Fungi.

Module 3: [12L]

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

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

Microbial Metabolism: Metabolic pathways, amphibolic and biosynthetic pathways

Bacterial Reproduction: Binary fission, Budding and Fragmentation.

Bacterial way of perennation: Encystment and Sporulation

Natural genetic recombination: Transformation, Transduction, Conjugation

Module 4: [10L]

Microbial control techniques Terms: Sterilization, Disinfection, Germicide/microbicide, Sepsis, Sanitization

Sterilization techniques:

(A) Physical methods:

(a) Heat: (i)Dry heat (ii)Moist heat

(b) Radiation: (i) Non-ionising radiation (Ultraviolet radiation) (ii) Ionising radiation (X-ray, gamma ray)

(c) Filtration; Pasteurization, Autoclave

(B). Chemical methods.

Biosafety levels in laboratory

Module5: [8L]

Bio indicator of drinking water: Coliforms and Fecal Coliforms. Waste Water management.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	1	-	-	-	-	-	-	-
CO 4	2	2	-	1	-	-	1	-	-	-	-	-
CO 5	2	1	1	-	-	-	-	1	-	-	-	-

Course Code	XBT4101			
Course Title	MICROBIOLOGY LABORATORY			
Category	MAJOR COURSE			
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 and enumeration of bacteria from different sources (air, water, food). **[3 days]**

4. Determination of bacterial cell size and shape. **[1 day]**

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

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	1	-	-	-	-	-	-	-

Course Code	XBT4002			
Course Title	MOLECULAR BIOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	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 protein 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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3		1	-	-	-	-	-	-	-	-	3
CO 2	2	1	-	-	2	-	-	-	-	-	-	3
CO 3	-	-	2	-	3	-	-	-	1	-	-	2

Course Code	XBT4102			
Course Title	MOLECULAR BIOLOGY LABORATORY			
Category	MAJOR 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. Isolation of genomic and plasmid DNA from bacterial cells. **[1 day]**
2. Agarose gel electrophoresis of genomic and plasmid DNA **[1 day]**
3. Estimation of DNA sample purity **[1 day]**
4. Preparation of restriction enzyme digests of DNA samples **[2 days]**
5. Protein extraction and quantification **[2 days]**

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	-	3	2	-	2	-	-	-	-	-	1	-
CO 2	-	2	-	3	-	-	-	-	-	-	-	3
CO 3	3	-	3	-	-	-	-	-	-	-	-	2

Course Code	XBT4003			
Course Title	INORGANIC CHEMISTRY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	10+2 chemistry knowledge			

Learning objective:
Students will be empowered with basic to advance knowledge of inorganic chemistry.

Course outcome:
Students will gain an understanding of:
CO1: the bonding fundamentals for both ionic and covalent compounds, including electronegativity, bond distances and bond energies using MO diagrams and thermodynamic data
CO2: predicting geometries of simple molecules
CO3: the bonding models, structures, reactivity, and applications of coordination complexes, boron hydrides, metal carbonyls, and organometallics
CO4: The fundamentals of acid/base equilibria, including pH calculations, buffer behavior, acid/base titrations.

Course content:
Module I: Atomic Structure and Chemical Periodicity (12L)
X-ray spectra and atomic number, Bohr's theory of hydrogen atom, Sommerfeld's extension of Bohr's theory, Wave mechanics: deBroglie equation, Heisenberg's Uncertainty principle and its significance, Schrödinger wave equation, quantum numbers and their significance, Normalized and orthogonal wave functions, spectrum of hydrogen atom, radial and angular wave functions, Quantum numbers and concept of orbitals, shapes of s, p, d, f- orbitals, Aufbau principle, Pauli's exclusion principle, Hund's rule, effective nuclear charge, Slater rule.
Periodic classification of elements, modern form of Periodic table, periodicity of properties: atomic radii, ionic radii, covalent radii, van der Waals radii, ionisation energy, electron affinity, electronegativity (Pauling, Mulliken-Jaffe, Allred and Rochow scales), ionic potential. Applications in predicting the chemical behaviour of different elements, and inert pair effect.

Module II: Chemical Bonding and Structure: (12L)

(a) Ionic Bonding: General characteristics of ionic compounds: ionization energy, electron affinity etc. Sizes of ions, radius ratio rule and its limitation. Lattice energy, Born-Haber cycle.

(b) Covalent Bonding: General characteristics of covalent compounds, valence bond approach, directional character of covalent bond, hybridization involving s-, p- and d-orbitals. Valence State Electron Pair Repulsion (VSEPR) concept, shapes pf simple

molecules and ions. Fajan's Rules. Hydrogen bonding and its effect of physical and chemical properties. Others types of molecular interaction.

Module III: Coordination Chemistry (12L)

IUPAC Nomenclature, Werner's theory, isomerism, Chelate effect, polynuclear complexes, labile and inert complexes, stereochemistry of coordination compounds with coordination numbers 4, 5 and 6.

Sedgwick's EAN concept and Valence Bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding, limitations of valence bond theory, crystal-field theory, measurement of 10 Dq (Δo), CFSE in weakand strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Term symbol, Laporte selection rules, charge transfer spectra, Orgel diagram, Tanabe-Sugano diagram, Nephelauxetic effect, Racah parameter, vibronic coupling, band broadening, spin-orbit coupling, spin-forbidden transition, intensity stealing, magnetic properties, anomalous and subnormal magnetic moments. Qualitative aspects of Ligand field and Molecular Orbital theory.

Module IV: Acid base and Non aqueous (12L)

Acid-base reactions**,** Arrhenius concept, theory of solvent system (in H_2O, NH_3, SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling rules, amphoterism, Lux-Flood concept, Lewis concept, Superacids, HSAB principle, acid base equilibria in aqueous solution and pH Acid-base neutralisation curves, indicator, choice of indicators. Physical properties of a non-aqueous solvent for functioning as an effective reaction medium, types of solvents and their general characteristics, liquid NH_3 as a non-aqueous solvent.

Recommended Books

1.Concise Inorganic Chemistry, J. D. Lee, 5th Edition (1996), Chapman & Hall, London.
2 Inorganic Chemistry, J.E. Huheey, E.A. Keiter and R.L. Keiter.
3. Inorganic Chemistry, Asim K. Das
4. Basic Inorganic Chemistry, F. A Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
5. Inorganic Chemistry, A. G. Sharpe, 3rd International Student Edition (1999), ELBS /Longman, U.K.
6. Inorganic Chemistry, D. F. Shriver and P. W. Atkins, 3rd Edition (1999), ELBS, London.

CO-PO Mapping:

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

Course Code	XBT4103			
Course Title	INORGANIC CHEMISTRY LABORATORY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	10+2 chemistry knowledge			

Learning objective:
To analyze chemical composition of various salts, quantitative estimation of metal ions and anions, synthesis and structure analysis of inorganic complexes.

Course objective:
Students will gain an understanding of:
CO1: common laboratory techniques including pH measurement, acid/base titrations, UV/Visible spectroscopy in emission and absorption mode, calorimetry, and colorimetry.
CO2: the use of the techniques mentioned above to solve chemical problems.
CO3: how to carry out self-directed experiments
CO4: practical laboratory experiments

Suggestive list of experiments:

A. Titrimetric Analysis
(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants
B. Acid-Base Titrations
(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents
C. Oxidation-Reduction Titrimetry
(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.
Any other experiment carried out in the class.

Recommended Books
1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
3. G. N. Mukherjee, Handbook of Practical Chemistry

CO-PO Mapping:

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

Course Code				
Course Title	VALUES AND ETHICS			
Category	ABILITY ENHANCEMENT COURSE			
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**
THEORY								
1	MAJOR	XBT5001	Genetics	4	0	0	4	4
2	MAJOR	XBT5002	Recombinant DNA technology	4	0	0	4	4
3	MINOR	XBT5003	Biophysical Chemistry	4	0	0	4	4
PRACTICAL								
4	MAJOR PRACTICAL	XBT5102	Recombinant DNA technology Laboratory	0	0	3	2	3
5	MINOR PRACTICAL	XBT5103	Biophysical Chemistry Laboratory	0	0	3	2	3
6	SEC	XBT5104	Summer Internship	0	0	0	4	0
	TOTAL			**12**	**0**	**6**	**20**	**18**

Course Code	XBT5001			
Course Title	GENETICS			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	NONE			

Learning objectives: A comprehensive and In-depth understanding of classical genetic principles and techniques. It explores the foundations of genetic inheritance, linkage, and mapping, as well as the application of classical genetics in understanding genetic traits and patterns.

Course Outcome:
CO1: Understanding the basic principles of genetics, including Mendelian inheritance, molecular genetics, population genetics and in-depth understanding of key concepts in various aspects of breeding, genetic adaptations and epigenetics.
CO2: In-depth understanding on the principles and mechanisms of inheritance and developing proficiency in classical genetic techniques, including genetic mapping and analysis of genetic traits.
CO3: Detail understanding of genetic crosses and pedigrees to analyze and predict patterns of inheritance with in-depth knowledge of quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.
CO4: Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.

Course Content:
MODULE 1: [6L]
History of genetics: Introduction and brief history of genetics. **Mendelian theory**: Laws of Inheritance- Dominance, Segregation and Independent Assortment. Monohybrid cross, Reciprocal cross, Back cross, Test cross, Dihybrids, Trihybrids, Chromosomal theory of inheritance.

MODULE 2: [10L]
Extensions to Mendelism- Co-dominance and Incomplete dominance; Epistasis and pleiotropism; Lethal and sub-lethal genes; Multiple alleles- Eye colour in Drosophila, ABO blood groups in humans, Rh blood group incompatibility, Penetrance and Expressivity, Holandric genes.
Heredity and Environment: Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines.
Non-Mendelian inheritance- Evidences for Cytoplasmic factors, cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance.
Deviation from Mendel's Dihybrid phenotype: Sutton's view on linkage, Morgan's view on linkage, Bateson and Punnet's Coupling and Repulsion hypothesis.
Deviation from Mendelism and inheritance of complex trait: Complex patterns of inheritance, quantitative traits, Inbreeding and resemblance between relatives; Genes and environment.

MODULE 3: [12L]

Linkage, Recombination and Crossing Over- Chromosome theory of linkage, Kinds of linkage, Linkage groups and significance of linkage, The mechanism of linkage.

Types of Crossing over, Mechanism of crossing over- Chiasma type theory, Breakage first theory, contact first theory, Strain or torsion theory, Molecular mechanism of crossing over- Holiday model, Crossing over in Drosophila, Cytological detection of crossing over, Significance of crossing over.

Kinds of recombination, Mechanisms and significance of recombination, Recombination mapping with two-point and three-point test cross, recombination frequency and genetic map distance.

Detection of linkage in experimental organisms: Tetrad analysis in fungi, balancer chromosome technique to assign a gene to a chromosome in Drosophila, Centromere mapping in ordered tetrads in Neurospora, Cytogenetic mapping in Drosophila, detection of linked loci by pedigree analysis in Humans, The *chi square* test for linkage, Coincidence and interference.

MODULE 4: [8L]

Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination. Quantitative inheritance- Concept, Genes and Environment, Polygenic inheritance, heritability and its measurements, QTL mapping. Cytoplasmic inheritance- Basis and mechanism, role of organellar genes.

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

MODULE 5: [12L]

Human Cytogenetics: Human chromosomes, karyotype, Banding techniques, classification, autosomal and sex chromosomal abnormalities and common genetic disorders, viable monosomies & trisomies, Genomic position effects on Gene expression.

Mutation: Types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Structural alterations of chromosomes: Deletion, duplication, inversion, translocation,

Numerical alterations of chromosomes: Change of ploidy

Text / Reference Books:

1. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Son Publications
2. Principles of Genetics by D. Peter Snustad and Michael J Simmons
3. Basic Genetics- Daniel L. Hartl, Jones & Barlett Publishers USA
4. Genes I - Benjamin Lewin, Wiley Eastern Ltd., Delhi
5. Genes II - Benjamin Lewin, Wiley & Sons Publications
6. Genes III- Benjamin Lewin, Wiley & Sons Publications
7. Genes V - Benjamin Lewin, Oxford University Press.
8. An Introduction to Genetic Analysis Griffith A. F. et al Freeman
9. iGenetics: A Molecular Approach by peter J. Russell (2016), Pearson Education
10. The Cell: A Molecular Approach by Geoffery M Cooper, (2013), 6th Edition, Sinauer Associates Inc

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**
CO 1	3	2	-	-	-	-	-	-	1	-	1	1
CO 2	3	2	-	-	-	-	1	-	-	1	-	1
CO 3	2	1	-	-	1	1	-	-	1	-	1	-
CO 4	2	-	-	1	-	-	-	-	-	1	1	-

Course Code	XBT5002			
Course Title	RECOMBINANT DNA TECHNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of molecular biology			

Learning Objective:

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

Course Outcome:

CO1: Understand genomic organization of prokaryotes including bacterial chromosome, vectors including bacterial plasmids, yeast and phage-based vectors as well as enzymes which are indispensable in RDT

CO2: Understand foreign gene delivering systems in prokaryotes, eukaryotes and plants

CO3: Understand PCR, sequencing techniques and gDNA, cDNA library screening

CO4: Applications of recombinant DNA technology and the role of microbes in rDNA technology

Course Content:

Module 1: Molecular Cloning- Tools and Strategies [16L]

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

Module 2: Methods in molecular cloning [14L]

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

Module 3: PCR, sequencing and construction genomic, cDNA libraries [12L]

PCR: Basics of PCR, RT-PCR, Real-Time PCR; Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing**,** Genomic and cDNA libraries: Preparation and uses, screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Module 4: Applications of RDT **[6L]**

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

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1110**	**PO11**	**PO12**
CO 1	2	2	1	3	1	-	-	-	-	-	-	-
CO 2	2	2	2	2	1	-	-	-	-	-	-	-
CO 3	2	2	2	3	1	-	-	-	-	-	-	-
CO 4	2	3	3	1	-	3	-	-	1	-	-	-

Course Code	XBT5102			
Course Title	RECOMBINANT DNA TECHNOLOGY LABORATORY			
Category	MAJOR 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 recombinant DNA technology and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of recombinant DNA technology.

Course Outcome:

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

CO2: Impart knowledge about techniques in Recombinant DNA Technology.

CO3: Learn about production of Recombinant products.

CO4: Know about emerging techniques in Recombinant DNA Technology

Suggestive List of Experiments:

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

Text / Reference Books:

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	2	1	1	-	-	-	-	-	-	-
CO 4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XBT5003			
Course Title	BIOPHYSICAL CHEMISTRY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of organic, inorganic and physical chemistry			

Learning objectives:

The main objective of the course is to know the principles of physical and biophysical Chemistry. The objective is also to understand the basics of methods used in laboratory to describe bio macromolecules and their interactions in cells and on single-molecule level.

Course outcome:

CO1: Will be able to know principles of biophysical chemistry and their application in thermodynamic characterization and analysis of macromolecules

CO2: Will be able to determine and calculates association/dissociation constants and kinetic constants with the use of known physicochemical methods.

CO3: Will be aware of biophysical methods to study the biomolecules in bulk and at single-molecule level

CO4: Will be able to make the synthesis of information from various sources and is capable of correct conclusions based on them

Course content:

Module 1: Principles of physical chemistry (basic rules and constants).

Module 2: Thermodynamics (I-III thermodynamic laws, enthalpy, entropy, Gibbs energy) and its application in characterization of proteins by ITC and DSC calorimetries.

Module 3: Chemical equilibria with special attantion to acid-base equilibria of peptides and proteins and association/dissociation constant in biochemistry.

Module 4: Chemical kinetics with enzymology.

Module 5: Methods dedicated to study protein conformation – circular dichroism, CryoEM, NMR.

Module 6: Mass spectrometry - principles of operations and application in macromolecules analysis.

Module 7: Principles of electrochemistry and nanopore based measurements.

Module 8: Fluorimetry and its applications from cell imaging to single-molecule measurements.

Recommended Books:

1) Biophysical Chemistry, A. Cooper (RSC Publishing).
2) Biological thermodynamics, D.T. Haynie (Cambridge University Press).
3) Physical Chemistry, A.G. Whittaker, A.R. Mount, M.R. Heal (Physical Chemistry, A.G. Whittaker, A.R. Mount, M.R. Heal).
4) An Introduction to Single Molecule Biophysics Yuri L. Lyubchenko (CRC Press)

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	-	-	-	-	1	-	1	1
CO 2	3	2	-	-	-	-	1	-	-	1	-	1
CO 3	2	1	-	-	1	1	-	-	1	-	1	-
CO 4	2	-	-	1	-	-	-	-	-	1	1	-

Course Code	XBT5103			
Course Title	BIOPHYSICAL CHEMISTRY LABORATORY			
Category	MINOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	Basic knowledge of organic, inorganic and physical chemistry			

Learning Objective:

To impart scientific approach and to familiarize with the experiments in chemistry relevant and to Provide the students with a solid foundation in Chemistry laboratory required to solve engineering problems and practical implementation of fundamental concepts.

Course Outcomes:

CO1: Students will demonstrate a core knowledge base in the theory and practice of modern Biophysics

CO2: Students will function successfully in the laboratory and use safe laboratory practices.

CO3: Students will critically evaluate data and design experiments to test hypotheses relevant to the practice of biophysics.

CO4: Students will read and evaluate primary literature in the discipline.

Suggestive List of Experiment:

1. To familiarize in the use of pH meter and Colorimeter.
2. One-dimensional Ascending & Descending Paper chromatography of Amino acids & sugars
3. One-dimensional Ascending & Descending TLC of Amino acids & sugars
4. Fractionation of Sugars from fruit juice using TLC/HPTLC
5. Column Chromatography for Proteins, Pigments, amino acids.
6. To study the structure based visco-elastic properties of proteins, nucleic acids, sugars, lipids, enzyme using Ostwald's Viscometer.
7. Identification of simple organic compound by IR and NMR spectroscopy based on the provided spectra.

Recommended Books

1. Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	-	-	-	-	1	-	1	1
CO 2	3	2	-	-	-	-	1	-	-	1	-	1
CO 3	2	1	-	-	1	1	-	-	1	-	1	-
CO 4	2	-	-	1	-	-	-	-	-	1	1	-

Detail Syllabus B.Sc. Biotechnology Semester-6

SEMESTER-6								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT6001	Virology	4	0	0	4	4
2	MAJOR	XBT6002	Immunology	4	0	0	4	4
3	MAJOR	XBT6003	Medical Biotechnology	4	0	0	4	4
4	MAJOR	XBT6004	Bioinformatics	4	0	0	4	4
PRACTICAL								
5	MAJOR PRACTICAL	XBT6102	Immunology Laboratory	0	0	3	2	3
6	MAJOR PRACTICAL	XBT6104	Bioinformatics Laboratory	0	0	3	2	3
	TOTAL			**16**	**0**	**6**	**20**	**22**

Course Code	XBT6001			
Course Title	VIROLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	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: **[4L]**

Classification and Morphology of Viruses: Cataloguing the virus through virus classification schemes of ICTV, Baltimore, Morphology, Host of infection, Viral structure. Morphology and ultra-structure of viruses. Virus related agents, viroids and prions.

Module 2: **[10L]**

Transduction: Generalised and Specialised and its application.

Viral life cycle (lytic and lysogenic), growth and infection into the host of T4 and lambda phage. Survival of T4 inside host (5-HMC), Terminal Redundancy, Cyclic permutation in T4 genome. Headful packaging mechanism of viral genome.
Site specific Recombination technique of Lambda phage integration into host DNA, Genetic switch of Lambda phage (lytic and lysogenic life maintenance),

Module 3: **[12L]**
Cultivation and assay of viruses: Cultivation of animal viruses using embryonated eggs, cell cultures (Cell-lines, cell strains and transgenic systems).
Cultivation of bacteriophage and Infectivity Assays using plaque assay, PFU, MOI counting. Cultivation of plant viruses (TMV) by plant infection study.
Diagnostic tools for virus: Physical Methods-Light and Electron Microscopy.
Molecular techniques- Western Blotting, PCR, Microarray. Immuno-techniques: Hemagglutination, Neutralization, Complement fixation, ELISA

Module 4: **[8L]**
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: **[14L]**
Pathogenesis and Control of Viruses: Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses: Herpes virus (HSV), Hepatitis virus (HBV, HCV), Cytomegalo virus (CMV), Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV]. Structure, genomic organization, pathogenesis and control of HIV. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.
Control of viral infections through vaccines: Recombinant vector & protein vaccines, DNA vacccines, Interferons, Cytokines. Study of Viral Chemotherapeutic agents.

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

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	1	-	-	-	-	-	-	-	-	2
CO 2	3	-	2	-	-	-	-	-	-	-	-	2
CO 3	3	2	2	-	-	-	-	-	-	-	-	2
CO 4	-	2	-	1	-	-	-	-	-	-	1	2
CO 5	3	-	2	-	-	-	-	-	--	-	-	2

Course Code	XBT6002			
Course Title	IMMUNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of molecular biology, cell biology, genetics			

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: **AN INTRODUCTION TO IMMUNOBIOLOGY [6L]**

Primary and secondary lymphoid organs, their structure and function; Cells of immune system; hematopoiesis and differentiation; Structure and role of B and T lymphocytes, NK cells, macrophages, Dendritic cells, mast cells, eosinophils, basophils and neutrophils.

Module 2: IMMUNE RESPONSES [8L]

Innate and acquired immunity, Basics of humoral and cell mediated immune response; Lines of defence and various barriers; Clonal nature of immune response; Primary and secondary immune response; Inflammatory response; The Complement system.

Module 3: **ANTIGEN AND ANTIBODY [14L]**

Antigen and Immunogen, antigenicity vs immunogenicity, properties of antigens; Hapten and Adjuvants; Antibody molecule, types and structure; Antigenic determinant of antibody- isotype, allotype, idiotype; Antibody function; monoclonal and polyclonal antibody; Hybridoma technology. B cell receptor, T cell receptor. Primary immunoglobulin gene rearrangement. Secondary diversification of the antibody

repertoire. Antigen antibody Interaction-Immunodiffusion, RIA & ELISA, Immuno-electrophoresis.

Module 4: **[14L]**

ANTIGEN PROCESSING AND PRESENTATION: The major histocompatibility complex (MHC) and Cytokines-MHC molecule and its types, structure and their function, Cytokines and their role in immune response. Antigen processing by MHC-I and MHC-II. Antigen Presentation to T-Lymphocytes. Overview of hypersensitivity and autoimmunity.

THE ADAPTIVE IMMUNE RESPONSE- T Cell-Mediated Immunity, General properties of effector T cells and their cytokines, T cell-mediated cytotoxicity, Macrophage and B cell activation by T cells, TD and TI antigen**.**

Module 5: VACCINES & VACCINATION [6L]

Active and Passive Immunization; Designing Vaccines for Active Immunization; Whole-Organism Vaccines; Purified Macromolecules as Vaccines; Recombinant-Vector Vaccines; DNA Vaccines; Multivalent Subunit Vaccines; mRNA Vaccines.

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	-	-	-	-	-	-	-	-	-	3
CO 2	3	-	3	-	-	-	-	-	-	-	-	2
CO 3	3	1	3	-	-	-	-	-	1	-	-	2
CO 4	-	-	-	-	3	-	-	-	-	-	2	3

Course Code	XBT6102			
Course Title	IMMUNOLOGY LABORATORY			
Category	MAJOR 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. PBMC isolation from blood **[1 day]**
2. Haemagglutination assay **[1 day]**
3. Separation of serum and plasma from blood **[1day]**
4. Double immunodiffusion test using specific antibody and antigen. **[2 days]**
5. Radial immunodiffusion **[2days]**
6. Dot-ELISA. **[1day]**

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	-	2	-	-	-	-	-	-	-	-	3
CO 2	-	3	3	3	-	-	-	-	-	-	-	2
CO 3	-	1	-	2	-	-	-	-	-	-	-	2
CO 4	-	-	-	-	3	-	1	-	-	-	2	3

Course Code	XBT6003			
Course Title	MEDICAL BIOTECHNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of Molecular biology, Genetics, RDT, Microbiology			

Learning Objective:

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

Course outcome:

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

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

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

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

Course Content:

Module 1: Normal microflora of the human body and host pathogen interaction [10 Hrs]

Normal microflora of the human body: Definition and significance of normal microflora, Composition and diversity of microbial communities in different body sites. Gnotobiotic study. Methods for studying the human microbiota, Factors influencing the establishment and composition of normal microflora; Microbial Communities in specific body Sites: Oral microbiota and its role in oral disease, Gut microbiota and its impact on digestion, metabolism, and immune function, Skin microbiota and its influence on skin health and protection, Genitourinary microbiota and its relevance to urinary and reproductive health; Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity- Pathophysiologic effects of LPS, Carriers and their types, Opportunistic infections, Hospital borne infections. Transmission of infection.

Module 2: Sample collection, transport and diagnosis [10 Hrs]

Collection, transport and culture and storage of clinical samples, Principles of different diagnostic tests: Immunological and serological Assay (ELISA, Immunoblotting, Immuno-fluorescence assay, Immunohistochemistry, Hemagglutination assay, Flow Cytometry, Complement fixation); Molecular Assay: PCR, qPCR, Multiplex PCR, RT-PCR, Nucleic Acid Hybridization, Next-Generation Sequencing, Loop-mediated Isothermal Amplification (LAMP), Whole-Genome Sequencing (WGS), CRISPR-Cas Systems.

Module 3: Microbial diseases [10 Hrs]

Introduction to Microbial Diseases: Overview of microbial diseases and their impact on public health, Host-microbe interactions and disease transmission, Principles of infection control and prevention; Bacterial Infections: Bacterial pathogenesis and virulence factors, Clinical manifestations, diagnosis, and treatment of common bacterial infections, Viral Infections: Viral pathogenesis, Clinical manifestations, diagnosis, and treatment; Fungal Infections: Pathogenic fungi and their clinical significance, Clinical manifestations, diagnosis, and treatment, Antifungal agents; Parasitic Infections: Parasitic diseases and their impact, Clinical manifestations, diagnosis and treatment, Control and prevention strategies.

Module 4: Antimicrobial agents and Immunological techniques [10 Hrs]

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumours, tumour Antigens, causes and therapy for cancers; Antimicrobial Agents and Resistance: Mechanisms of action of antimicrobial agents, Antibiotics, antifungals, and antiparasitic drugs, Mechanisms and spread of antimicrobial resistance, MDR,-XDR, MRSA, NDM-1,-Strategies for antimicrobial stewardship.

Text / Reference Books:

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

6. Microbiology: An Introduction, 13th Edition. **Authors: Gerard J. Tortora, Berdell R. Funke and Christine L. Case**
7. Bailey & Scott's Diagnostic Microbiology, 14th Edition. **Patricia Tille**

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	2	1	-	-	2	1	-	-	1	-
CO 3	-	2	2	1	1	1	-	-	-	-	-	-
CO 4	1	2	2	1	-	3	-	-	1	-	-	-

Course Code	XBT6004			
Course Title	BIOINFORMATICS			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Knowledge of genetics, molecular biology			

Learning Objective:
The course introduces the fundamental principles and techniques of bioinformatics. It is also combines biology, computer science, and statistics to analyze and interpret biological data, various bioinformatics algorithms, databases, and tools used for sequence analysis, genome analysis, protein structure prediction, and functional annotation. Students will gain a solid foundation in theory, its application in biological research.

Course Outcome:
CO1: Understanding the principles and scope of bioinformatics.
CO2: Analyzing and interpreting biological sequences using bioinformatics tools and algorithms.
CO3: Performing genome analysis and comparative genomics; predicting protein structure and function using computational methods.
CO4: Applying statistical techniques in bioinformatics data analysis and critically evaluating bioinformatics resources and databases.

Course Content:

MODULE I: Introduction to bioinformatics [10L]
Concept of operating system, Programming languages used in bioinformatics, algorithm, Database management. Biological Databases: Overview, Applications, Prospects; Modes of database search, data storage (flat file, db-tables); Gene and protein sequence databases; GenBank, BLAST, EMBL, DDBJ, PDB etc.

MODULE II: Sequence alignment and sequence analysis [12L]
Concept of local and global sequence alignment, Pairwise sequence alignment: Needleman-Wunsch and Smith-Waterman algorithms; Multiple sequence alignment: homology, analogy: ClustalW, MUSCLE, and MAFFT algorithms; T-Coffee, GeneDoc, Sequence motifs and pattern discovery; Hidden Markov Models (HMMs) in sequence analysis, scoring an alignment, substitutional matrices, Pattern recognition.

MODULE III: Genome Analysis [12L]
Genome annotation tools: GeneMark, AUGUSTUS, or Prokka; Comparative genomics analysis using software: OrthoMCL or VISTA; Identification of genomic variations and single nucleotide polymorphisms (SNPs); Visualization of genome features and comparative genomics data.

MODULE IV: Protein Structure Prediction and statistics [14L]

Protein structure databases and structure visualization tools; Protein structure prediction methods: homology modelling; Protein folding and energy minimization algorithms; Structural analysis and validation of predicted protein structures. Statistical concepts in bioinformatics: hypothesis testing, p-values, and multiple testing corrections; Statistical techniques for analyzing microarray and next-generation sequencing data, Evaluation and interpretation of bioinformatics results.

Text / Reference Books:

1. Bioinformatics: An Introduction (Computational Biology, 21) 4th ed. 2023 Edition by Jeremy Ramsden
2. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004.
3. Introduction to Bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson.
4. Introduction to Bioinformatics, Arthur Lesk, Oxford University Press, 2019.
5. Bioinformatics, System Biology and Big Data Analysis: Emerging Trends: Bioinformatics, System Biology and Big Data Analysis by Dr. Neetu Jabalia, N. Jaya Lakshmi.
6. Bioinformatics for DNA Sequence Analysis (Methods in Molecular Biology, 537) 2009th Edition by David Posada.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	1	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	1	-	-	-	-	-	-	1
CO 3	3	3	3	3	1	-	-	-	-	-	-	1
CO 4	2	3	2	1	-	-	-	-	-	1	1	-

Course Code	XBT6104			
Course Title	BIOINFORMATICS LABORATORY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	0	0	3	2
Total Contact Hours	36			
Pre-requisites	Knowledge of genetics, molecular biology			

Learning Objective:
The course provides hands-on experience in applying bioinformatics techniques and tools to analyze biological data. Through practical exercises, data analysis, and scientific report writing, students will develop proficiency in bioinformatics methods, data manipulation, and data visualization.

Course Outcome:
CO1: Apply bioinformatics tools and software for sequence analysis, genome analysis, and protein structure prediction.
CO2: Manipulate and analyze biological data and scripting to interpret and visualize bioinformatics results effectively.
CO3: Design and execute bioinformatics workflows for specific research questions.

Suggestive List of Experiments:

1. Introduction to Bioinformatics Tools and Resources: Familiarization with bioinformatics software and databases; Retrieval and manipulation of biological data; Introduction to command-line tools and scripting for bioinformatics. **[2days]**

2. Sequence Analysis: Pairwise sequence alignment using tools like BLAST and ClustalW; Multiple sequence alignment using software such as MUSCLE or MAFFT; Identification and analysis of sequence motifs and patterns; Profile Hidden Markov Models (HMMs) for sequence analysis. **[2days]**

3. Genome Analysis: Genome annotation using tools like GeneMark, AUGUSTUS, or Prokka; Comparative genomics analysis using software such as OrthoMCL or VISTA; Identification of genomic variations and single nucleotide polymorphisms (SNPs); Visualization of genome features and comparative genomics data. **[2days]**

4. Protein Structure Prediction: Homology modeling of protein structures using software like MODELLER or SWISS-MODEL; Protein structure visualization and analysis using tools such as PyMOL or Chimera; Structure prediction validation and assessment of model quality; Protein-ligand docking studies and analysis of binding interactions. **[2days]**

5. Transcriptomics and Gene Expression Analysis: Preprocessing and quality control of RNA-Seq data; Analysis of differential gene expression using tools like DESeq2 or edgeR; Gene ontology and pathway enrichment analysis; Visualization of gene expression data using heatmaps or volcano plots. **[2days]**

6. Functional Analysis and Visualization: Functional annotation using databases such as Gene Ontology (GO) or KEGG; Network analysis and visualization using tools like Cytoscape or STRING; Integration of omics data and pathway analysis; Data visualization techniques for biological data interpretation. **[2days]**

Suggested Readings

1. "Bioinformatics and Functional Genomics" by Jonathan Pevsner.
2. "An Introduction to Bioinformatics Algorithms" by Neil C. Jones and Pavel A. Pevzner.
3. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount.
4. "Practical Bioinformatics" by Michael Agostino and David Ochoa.
5. "Bioinformatics: Methods and Protocols" edited by Stephen Misener and Stephen A. Krawetz..
6. "Introduction to Bioinformatics" by Arthur M. Lesk
7. "Practical Guide to Bioinformatics Analysis" edited by Andreas D. Baxevanis.
8. "Essential Bioinformatics" by Jin Xiong.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	1	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	1	-	-	-	-	-	-	1
CO 3	3	3	3	3	1	-	-	-	-	-	-	1

Detail Syllabus B.Sc. Biotechnology Semester-7

SEMESTER-7								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT7001	Environmental Biotechnology	4	0	0	4	4
2	MAJOR	XBT7002	Bioprocess Technology	4	0	0	4	4
3	MAJOR	XBT7003	Developmental Biology	4	0	0	4	4
PRACTICAL								
5	MAJOR PRACTICAL	XBT7101	Project work	0	0	12	8	12
	TOTAL			**12**	**0**	**12**	**20**	**24**

Course Code	XBT7001			
Course Title	ENVIRONMENTAL BIOTECHNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	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:

CO 1: Able to understand the concept and the potential of Alternative energy sources.

CO 2: Able to impart knowledge on the process of biodegradation and bioremediation.

CO 3: Able to learn about the environmental quality evaluation, monitoring, and remediation of contaminated environments.

CO 4: Able to understand about different types of wastes and their eco-friendly management

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. Alternative energy sources - Biofuels: Production of bioethanol, biobutanol from agriculture waste -Problems and perspectives - Biodiesels: mass cultivation of Jatropa and use of Jatropa, marine algae for production of biodiesel.

Module 2: [12L]

Bioremediation of soil & water contaminated with waste - BHC, DDT, nitro phenols, polycyclic aromatic carbons: oil spills, heavy metals and detergents. Phyto-remediation and microbe-assisted phyto-remediation. Nature of recalcitrant compounds - Anthropogenic activities generating recalcitrant chemical. Biodegradation – microbial conversion of recalcitrant toxic compounds. Bioremediation of aromatic, alkane and their halogenated forms. Biosensors for detecting pollution.

Module 3: **[12L]**

Biological methods of pest management - Biological control of weeds. Bacterial (BT), viral, fungal insecticides. Technology for mass production and formulation of biopesticides - Problems and prospects. Biofertilizers - Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, Regulation of nitrogen fixing genes (Nif genes). Manipulation of Nif genes for constitutive expression of nitrogenase, Algal and fungal biofertilizers (VAM), Important diazotropic microbes - Mass production of biofertilizers - Rhizobium, Azolla. Bio-fertilizers

Module 4: **[12L]**

Waste management and Bioleaching - Nature and classification of agriculture, domestic and industrial waste - Recycling methods, Solid waste treatment, Biological and non-biological methods of waste water treatment, Reclamation of treated waste water. Hospital waste management. Use of bioleaching in mining of oars (Gold, Copper and Uranium). Significance of genetically modified organisms in waste management.

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. Environmental Biotechnology by V Kumaresan and N Arumugam.

6. Environmental Biotechnology by Perry L McCarty and Bruce E Rittmann.

7. Textbook of Environmental Biotechnology by P K Mohapatra.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	3	2	2	1	1	-	-	1	-	1	1
CO 2	3	2	2	1	2	1	-	-	1	-	1	1
CO 3	3	3	2	1	1	2	-	-	1	-	1	1
CO 4	3	3	2	2	1	1	-	-	1	-	1	1

Course Code	XBT7002			
Course Title	BIOPROCESS TECHNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of microbiology			

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. Maintenance and preservation of microbes industrially used- Cryopreservation, Lyophilization

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)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	-	-	-	-	-	-	-	3
CO 2	3	2	-	-	-	-	-	-	1	-	-	2
CO 3	-	3	-	-	-	-	-	-	2	-	2	-

Course Code	XBT7003			
Course Title	DEVELOPMENTAL BIOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	None			

Learning objectives:
The objective of this course is to provide a comprehensive understanding of the concepts of early animal development.

Course Outcome:

CO1: Provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development
CO2: Impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction**.**
CO3: Provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis.

Course content:
Module 1: [8L]
Stem cell concept, cell specification, induction, cell signaling

Module 2: Early Embryonic Development [20L]
Gametogenesis, Spermatogenesis, Oogenesis in sea urchin and mammals; Types of eggs, Egg membranes; Fertilization; External and Internal: Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps; early development of frog and chick up to gastrulation; embryonic induction and organizers; Ultra-structure of ovum and sperm in sea urchin and mammals; types of placenta and its function along with examples.

Module 3: Late Embryonic Development [8L]
Fate of Germ Layers; Extra-embryonic membranes in birds

Module 4: Post EmbryonicDevelopment [12L]
Development of brain and eye in chick; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration

Text / Reference Books:

1. Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Schoenwolf G.
2. Schoenwolf GC, Bleyl SB, Brauer PR, Francis-West PH. 2009. Ladesn's Human Embryology.
3. Elsevier Slack JMW. 2012. Essential Developmental Biology. Wiley-Blackwell.

CO-PO Mapping:

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

Detail Syllabus B.Sc. Biotechnology Semester-8

SEMESTER-8								
Sl. No.	**Type**	**COURSE CODE**	**COURSE NAME**	**L**	**T**	**P**	**CREDITS**	**CONTACT HOURS**
THEORY								
1	MAJOR	XBT8001	Tissue Culture Technology	4	0	0	4	4
2	MAJOR	XBT8002	Protein Separation Technology	4	0	0	4	4
PRACTICAL								
5	MAJOR PRACTICAL	XBT8101	Project work	0	0	20	12	20
	TOTAL			**8**	**0**	**20**	**20**	**28**

Course Code	XBT8001			
Course Title	TISSUE CULTURE TECHNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of cell biology, molecular biology			

Learning Objective:

The course aims to provide knowledge, required for dealing with animal cell and tissue cultures in vitro and to prepare students capable to maintain animal cells and tissues under in vitro conditions.

Course outcome:

CO 1: Able to recall background history and major contributions in the field of animal and plant cell culture and related techniques

CO 2: Able to investigate about applications of stem cells in cell culture based biotherapeutics.

CO 3: Able to define utility of basic laboratory instruments routinely used in culture of animal and plant cells such as Biosafety cabinet class II, CO2 incubator, inverted microscope, liquid N2 etc.

CO 4: Able to describe all protocols and procedures related with isolation of tissues/cells from an organ or embryo, cell disaggregation and sub-culturing.

CO 5: Able to analyse different techniques basically used routinely in an animal cell culture lab such as proliferation assay, survival assay, transfection, immunoblotting, Co-IP, immunofluorescene etc.

Course Content:

Module 1: [12L]

Mammalian tissue culture laboratory design and equipment planning, construction and services; Layout; Sterile handling area; Incubation; Air circulation; Service bench; Laminar flow; Sterilizer; Incubator; CO2 incubator; Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer ;Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Washing, packing and sterilization of different

materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Module 2: [12L]

Tissue Culture Media and Reagents Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents. Cell lines, primary and established cell line cultures. Basic techniques of mammalian cell culture in vitro. Cell cloning and selection; Transfection and transformation of cells.

Module 3: [12L]

The biology of stem cells: Different types of stem cells – embryonic stem cells, fetal tissue stem cells, adult stem cells; stem cell potency, stem cell differentiation, stem cell plasticity. Differentiation versus stem cell renewal. Isolation and propagation of embryonic stem cells. Generation of knockout mice and knock-in technology. Importance of stem cells in regenerative medicine.

Module 4: [12L]

Plant tissue culture technology: Culture media – composition and preparation. Factors governing in vitro behaviour, Somatic embryogenesis, organogenesis and plant regeneration, embroid. Culture types. Micro propagation, Haploids, somaclonal variants, metabolite production in cultures. Isolation of protoplasts, protoplast fusion and culture. Somatic hybridization.

Text / Reference Books:

1. Butler M., Animal Cell Culture and Technology, Garland Science, 2004.

2. Freshney R. I., Culture of Animal Cells, John Wiley & Sons, 2010.

3. Doyle A., Griffiths J. B., Cell and Tissue Culture: Laboratory Procedures in Biotechnology, John Wiley & Sons, 1999.

CO-PO Mapping:

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	2	2	-	-	-	-	1	-	-	-	1	1
CO 2	2	2	1	-	-	-	-	-	-	1	-	-
CO 3	2	1	-	-	-	1	-	-	-	1	1	-

CO 4	1	1	-	-	-	-	-	1	-	-	-	1
CO 5	1	1	-	-	-	-	-	-	-	1	1	-

Course Code	XBT8002			
Course Title	PROTEIN SEPARATION TECHNOLOGY			
Category	MAJOR COURSE			
LTP & Credits	L	T	P	Credits
	4	0	0	4
Total Contact Hours	48			
Pre-requisites	Basic knowledge of protein			

Learning Objective:

The course is aimed at learn different aspects of protein purification strategies.

Course Outcome:

CO 1: To gain hands on experience in gene cloning, *protein expression and purification*.

CO 2: To illustrate creative use of modern tools and techniques that engages in genetic engineering as well as in research laboratories conducting fundamental research

CO3: To expose students in application of recombinant DNA technology in biotechnological research using various protein expression techniques.

CO4: To train students in strategizing research methodologies employing genetic engineering techniques to begin a career in industry.

Course Content

Module 1: Protein structure visualization and analysis: **[12L]**

Protein structure databases; PDB file format; visualization and analysis of protein structure; protein structure prediction; visualization and analysis of protein – protein interface; determining the contribution of H bond, hydrophobic interaction, salt bridge in complex formation; homology modelling; threading and fold recognition; Ab initio structure prediction, structure validation tools.

Module 2: Structural and functional analysis of protein-ligand and protein-nucleic acid complex: **[12L]**

Introduction to protein – ligand complex; protein – nucleic acid complex; visualization and determination of protein – ligand interaction; determining the contribution of H bond and hydrophobic interaction in ligand binding; Visualization of DNA and RNA structure; different types of RNA structure; RNA structure prediction; visualization and analysis of

protein – nucleic interaction and determining the contribution of H bond and hydrophobic interaction; Basic introduction to molecular docking and docking tools.

Module 3: Applications of structural bioinformatics: [12L]

Protein engineering; Drug designing: structure guided drug designing, brute force screening, rational drug designing; Vaccine designing: epitope prediction and multi epitope vaccine construction; Molecular dynamics simulation: brief introduction, workflow, result analysis and visualization of a sample trajectory using standard viewing tool; Conformational dynamics and role in protein function; catalytic mechanism linked to conformational dynamics (example: spring loaded mechanism).

Text / Reference Books:

1. Structure and mechanism in protein science a guide to enzyme catalysis and protein folding by Alan Fersht. (Freeman)
2. Introduction to protein structure by Carl Ivar Branden, John Tooze. (Garland Science)
3. Introduction to macromolecular crystallography by Alexander McPherson. (Wiley)
4. Biochemistry by Donald Voet and Judith G. Voet. (Wiley)
5. Proteins by Thomas E. Creighton. (Freeman)
6. Methods in Enzymology Vol: 182 (Academic Press)
7. Methods in Enzymology Vol: 463 (Academic Press)

8. CO-PO Mapping

	Programme Outcomes (PO)											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	-	-	-	1	-	-	-	1	-
CO 2	3	-	1	-	-	-	-	-	-	1	-	-
CO 3	2	1	-	-	-	1	-	-	-	1	1	-
CO 4	2	-	1	-	-	-	-	1	-	-	-	-

END OF SYLLABUS