TECHNO INDIA UNIVERSITY
WEST BENGAL

Syllabus for 4-Years B.Sc. in Biotechnology

Department of Biotechnology

Techno India University, West Bengal EM-4,
EM Block, Sector V, Bidhannagar, Kolkata,
West Bengal 700091

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First Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	
THEORY						
1	**TIU-UBT-MJ-T11101**	BiochemistryandMetabolism	3	1	0	4
2	**TIU-UCH-MI-T11101**	Chemistry–I	3	0	0	3
3	**TIU-UCA-MDC-T11101**	IntroductiontoComputer Applications	2	1	0	3
4	TIU-UEN-AEC-S1101	CommunicativeEnglish–I	2	0	0	2
5	**TIU-UBT-CVA-T1101**	EnvironmentalScience	2	0	0	2
PRACTICAL						
1	**TIU-UBT-MJ-L11101**	BiochemistryandMetabolism Lab	0	0	4	2
2	**TIU-UCH-MI-L11101**	Chemistry–ILab	0	0	2	1
3	**TIU-UBT-SEC-T1101**	InstrumentationTechnique–I	3	0	0	3
					TOTAL CREDIT	**20**

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Second Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	

THEORY						
1	**TIU-UBT-MJ-T12101**	IntroductiontoMicrobiology	3	1	0	4
2	**TIU-UCH-MI-T12101**	Chemistry–II	3	0	0	3
3	TIU-UBT-MD-T1202	DataScience	2	1	0	3
PRACTICAL						
1	**TIU-UBT-MJ-L12101**	MicrobialPhysiologyLab	0	0	4	2
2	**TIU-UCH-MI-L12101**	ChemistryLab	0	0	2	1
SESSIONAL						
1	**TIU-UEN-AEC-S1201**	CommunicativeEnglish–II	2	0	0	2
2	**TIU-UBT-SEC-S1201**	IndustrialFermentation	3	0	0	3
3	TIU-UBT-CVA-T1201	AI	2	0	0	2
					TOTAL CREDIT	**20**

Third Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	
THEORY						
1	**TIU-UBT-MJ-T21201**	MicrobialGenetics	3	1	0	4
2	**TIU-UBT-MJ-T21201**	BioprocessTechnology	3	1	0	4
3	**TIU-ULIB-MD-T2101**	LibraryandInformationScience	3	0	0	3
4	**TIU-UBT-SEC-T2101**	MolecularDiagnostics	3	0	0	3
PRACTICAL						
1	**TIU-UBT-MJ-L21201**	CytogeneticsLab	0	0	4	2
2	**TIU-UBT-MI-L21201**	BioprocessTechnologyLab	0	0	4	2
SESSIONAL						

1	TIU-UEN-AEC-T2101	Heritage of Modern Indian Languages-I	2	0	0	2
TOTAL CREDIT						**20**

Fourth Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	
THEORY						
1	**TIU-UBT-MJ-T22201**	MolecularBiology	3	1	0	4
2	**TIU-UBT-MJ-T22202**	ParasitologyandImmunology	3	1	0	4
3	**TIU-UBT-MI-T22201**	InstrumentationandTechnique- II	3	0	0	3
4	**TIU-UWS-CVA-T2201**	GenderStudies	2	0	0	2
PRACTICAL						
1	**TIU-UBT-MJ-L22201**	MolecularBiologyLab	0	0	4	2
2	**TIU-UBT-MJ-L22202**	ParasitologyandImmunology Lab	0	0	4	2
3	**TIU-UBT-MI-L22201**	MethodsinBiologyLab	0	0	2	1
SESSIONAL						
1	**TIU-UEN-AEC-S2291A/B**	ModernIndianLanguage–Hindi /Bengali	2	0	0	2
TOTAL CREDIT						**20**

Fifth Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	
THEORY						
1	**TIU-UBT-MJ-T31301**	PLANTCELLANDTISSUECULTURE	3	1	0	4
2	**TIU-UBT-MJ-T31302**	FOOD BIOTECHNOLOGY	3	1	0	4
3	TIU-UBT-MI-T31203	BIOSTATISTICS	3	1	0	4
PRACTICAL						

1	**TIU-UBT-MJ-L31302**	FOODANDPHARMACEUTICAL BIOTECHNOLOGY LAB	0	0	4	2
2	**TIU-UBT-MJ-L31351**	BIOSEPARATIONTECHNOLOGYLAB	0	0	4	2
3	TIU-UBT-SEC-I3101	INTERNSHIP	0	0	8	4
TOTAL CREDIT						**20**

Sixth Semester

S. No	**Course Code**	**Course Title**	**Contact Hrs. / Week**			**Credit**
			L	**T**	**P**	
THEORY						
1	**TIU-UBT-MJ-T32301**	PLANTBIOTECHNOLOGYAND MOLECULAR BIOLOGY	3	1	0	4
2	**TIU-UBT-MJ-T32302**	RECOMBINANTDNATECHNOLOGY	3	1	0	4
3	**TIU-UBT-MJ-T32303**	ANIMALPHYSIOLOGY	3	1	0	4
4	**TIU-UBT-MI-T32201**	GISANDREMOTESENSING	3	1	0	4
PRACTICAL						
1	**TIU-UBT-MJ-L32301**	PLANTBIOTECHNOLOGYLAB	0	0	4	2
2	**TIU-UBT-MJ-L32302**	RECOMBINANTDNATECHNOLOGY LAB	0	0	4	2
3	**TIU-UBT-MI-L32251**	MAMMALIANPHYSIOLOGYLAB	0	0	4	2
TOTAL CREDIT						**22**

Seventh semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	
1	**TIU-UBT-MJ-T41401**	GENOMICS,PROTEOMICSAND BIOINFORMATICS	3	1	0	4
2	**TIU-UBT-MJ-T41402**	NANOMATERIALSANDTISSUE ENGINEERING	3	1	0	4
3	**TIU-UBT-MI-T41301**	AGRICULTURAL BIOTECHNOLOGY	2	0	0	2
PRACTICAL						
1	**TIU-UBT-MJ-L41401**	MULTI-OMICSTECHNIQUELAB	0	0	4	2
2	**TIU-UBT-MJ-L41402**	NANOTECHNOLOGYLAB	0	0	4	2
3	**TIU-UBT-SEC-P4101**	RESEARCHPROJECT	0	0	8	4
TOTAL CREDIT- 18						

Eighth Semester(With Research)

S.	Course Code	Course Title	Contact Hrs. / Week	Credit

No			L	T	P	
THEORY						
1	**TIU-UBT-MJ-T42401**	ANIMALBIOTECHNOLOGY	3	1	0	4
2	**TIU-UBT-MJ-T42402**	MEDICAL AND PHARMACEUTICAL BIOTECHNOLOGY	3	1	0	4
3	**TIU-UBT-MI-T42301**	IPR	3	1	0	4
4	**TIU-UBT-SEC-P4201**	RESEARCHPROJECT	0	0	16	8
					TOTAL CREDIT	**20**

<u>Eighth Semester</u>(Without Research)

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit
			L	T	P	
THEORY						
1	**TIU-UBT-MJ-T42401**	ANIMALBIOTECHNOLOGY	3	1	0	4
2	**TIU-UBT-MJ-T42403**	ECOLOGYANDEVOLUTION	3	1	0	4
3	**TIU-UBT-MI-T42302**	DEVELOPMENTALBIOLOGY	3	1	0	4
4	**TIU-UBT-MI-**	ENVIRONMENTAL MANAGEMENTAND	3	1	0	4

	T42303	BIOREMEDIATION				
PRACTICAL						
1	**TIU-UBT-MI-L42302**	DEVELOPMENTALBIOLOGYLAB	0	0	4	2
2	**TIU-UBT-MI-L42303**	ENVIRONMENTAL MANAGEMENT AND BIOREMEDIATIONLAB	0	0	4	2
					TOTAL CREDIT	**20**

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Biochemistry and Metabolism (TIU-UBT-MJ-T11101**)**

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 1st Sem.
Course Title: Biochemistry and Metabolism	**Subject Code:** TIU-UBT-MJ-T11101
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1. Understanding Fundamental Biochemical Principles

Introduce students to core concepts of biochemistry, including pH, buffers, and thermodynamic principles such as entropy, enthalpy, and Gibbs free energy, to establish a foundation for biochemical reactions and cellular processes.

2. Exploring Biomolecular Structure and Function

Provide in-depth knowledge of the composition, structure, and function of key biomolecules, including nucleic acids, proteins, carbohydrates, lipids, hormones, and vitamins, with an emphasis on protein folding, motifs, and enzyme mechanisms.

3. Comprehending Metabolic Pathways and Energy Flow

Analyze major metabolic pathways, including carbohydrate metabolism (glycolysis, citric acid cycle, oxidative phosphorylation), lipid, amino acid, and nucleotide metabolism, as well as photosynthesis, to understand energy production and biomolecular synthesis in living systems.

COURSE OUTCOME:

CO Number	Course Outcomes	Knowledge Levels
CO-1:	Explain the Fundamental Principles of Biochemistry- Understand the concepts of pH, buffers, and thermodynamic principles such as entropy, enthalpy, and Gibbs free energy, and their significance in biochemical reactions.	K2
CO-2:	Identify and Describe Biomolecular Structures Recognize and recall the composition, structure, and function of biomolecules (nucleic acids, proteins, carbohydrates, lipids, hormones, and vitamins), including protein folding and molecular interactions.	(K1, K2)
CO-3:	Analyze Protein Structure-Function Relationships Examine structural features such as the Ramachandran plot, motifs, and folding patterns of proteins like Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase, and Chymotrypsin to understand their biological roles.	K4
CO-4:	Illustrate Key Metabolic Pathways Apply knowledge of carbohydrate metabolism (glycolysis, citric acid cycle, oxidative phosphorylation), lipid, amino acid, and nucleotide metabolism to explain energy production and biosynthesis.	K3
CO-5:	Evaluate Photosynthesis and Bioenergetics (K4) Analyze the mechanisms of photosynthesis and the role of metabolic pathways in energy transformation and storage in biological systems.	K4
CO-6:	Relate Biochemical Concepts to Biotechnology Applications (K3, K4) Apply biochemical principles to biotechnology, including enzyme kinetics, metabolic engineering, and biomolecular interactions, to solve real-world biological problems.	K3 , K4

COURSE CONTENT:

MODULE 1:		**20 Hours**
Introduction to biochemistry: pH, buffer, classical thermodynamics, entropy, enthalpy, Gibbs free energy.		
MODULE 2:		**20 Hours**

Unit II: Structure function of biomolecules: Composition, structure and function of biomolecules: nucleic acids (A, B, Z forms), amino acids, proteins (Ramachandran plot, folding secondary, tertiary and quaternary structure; domains; motif and folds (Myoglobin, Hemoglobin, Lysozyme, Ribonuclease A, Carboxypeptidase and Chymotrypsin), carbohydrates, lipids, hormones and vitamins.	
MODULE 3:	**20 Hours**
Unit III: Metabolism of biomolecules: Metabolism: carbohydrates (glycolysis, citric acid cycle and oxidative phosphorylation, lipid, amino acid and nucleotide metabolism, photosynthesis.)	
TOTAL LECTURES	**60 Hours**

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3		2								2	2	2		
CO-2	3		2								2	2	3		2
CO-3	3	2	3	2							2	3	3	2	3
CO-4	3	3	3	2							2	3	3	2	3
CO-5	3	2	3	2		2					2	3	3	2	3
CO-6	3	3	3	3	3				2	2	2	3	3	2	3

Chemistry-I (: TIU-UCH-MI-T11101**)**

Program: B.Sc. Biotechnology	**Year, Semester:** Ist year., 1st Sem.
Course Title: Chemistry-I	**Subject Code**: TIU-UCH-MI-T11101
Contact Hours/Week: 3-0-0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE

Understand the basic concept of structure of atom, covalent bonding, non covalent bonding thermodynamics, chemical kinetics ionic equilibria, nomenclature, stereochemistry, structures, reactivity, and mechanism of chemical reactions.

Apply the concept of thermodynamics, chemical kinetics, and ionic equilibria, in the relevant advanced and emerging field of biotechnological studies.

Apply the concept of covalent and non covalent bonding, in acquiring information regarding the metals used in any process of biotechnological system.

Remember the knowledge of stereochemistry and reaction mechanism in understanding the glimpse of the reaction pathways involved in the biotechnology process.

Understand the concept of various types of bonding, energy distributions in atomic and molecular orbital makes the student easier to understand the technology based on them.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	**Understand** the basic structure of an atom, dual nature of the subatomic particles, quantum mechanical model of the atom and shape of *s, p, d, f* orbital's which are basics of the bonding theories required to explain the properties of molecules and matters, the laws of thermodynamics and other thermodynamic parameters to explain conversion of heat into work and vice-versa, feasibility of a process, the factors which affect speed of chemical reactions and various methods to measure the rate of reactions that are relevant to the study of biological processes.	K2
CO-2:	**Understand** the different types of bonding (covalent, ionic, metallic, and weak interactions) and development of theories to explain the differences in properties of various types of molecules and matters.	K2
CO-3:	**Understand** the structural aspects of organic molecules and key factors required to explain stability and properties	K2
CO-4:	**Remember** the three-dimensional structure of organic molecules in various ways. They will also learn structure property correlation to explain two important properties of organic compounds which are optical activity and chirality.	K1
CO-5:	**Understand** the differences in properties of the three states of matter in terms of atomic hypothesis. They will also learn deviation of behaviour of real gas from the ideal one.	K2
CO-6:	**Apply** the laws of thermodynamics and other thermodynamic parameters to explain conversion of heat into work and vice-versa, feasibility of a process, the factors which affect speed of chemical reactions and various methods to measure the rate of reactions etc.	K3

COURSE CONTENT: ----------

MODULE 1:		**15 Hours**
1.	**ATOMIC STRUCTURE**	
Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics, de Broglie hypothesis, Heisenberg's uncertainty principle. Schrödinger equation. Hydrogen and hydrogen like systems (detail solution not required). Radial and angular parts of wave function, quantum numbers, shapes of s, p and d orbitals, Extension to multi electronic systems. Aufbau principle and its limitations, Pauli's exclusion principle, and Hund's rules of maximum multiplicity.		
2	**COVALENT BONDING**	

Lewis structure. VSEPR theory, shape and polarity of simple molecules and ions, Valence Bond Theory, concept of hybridization and shale of molecules. Molecular orbital theory, MO diagram of homonuclear and heteronuclear (CO & NO) diatomic molecules, HOMO, LUMO, Bond order.		
3	**NON COVALENT BONDING**	
(i) Ionic Bonding: General characteristics of ionic compounds. Ionization energy, electron affinity, lattice energy, Born-Haber cycle. **(ii) Metallic Bonding**: Theories of bonding in metals. Band theories. **(iii) Weak Interactions**: Hydrogen bonding and van der Waal's interactions.		
MODULE 2:		**15 Hours**
1.	**FUNDAMENTALS OF ORGANIC CHEMISTRY**	
Types of organic reactions, Inductive effect, resonance and hyper conjugation. nucleophiles and electrophiles		
2.	**BONDING IN ORGANIC MOLECULES**	
Concept of hybridization and formation of single, double and triple bonds, Resonance and resonance energy. Qualitative idea about molecular orbital's, bonding and anti bonding molecular orbital's, idea ofσ, σ*, π, π*, nonbonding MOs, concept of HOMO, LUMO and SOMO. Hückel's rules of aromaticity, anti aromaticity and non-aromaticity.		
3.	**STEREOCHEMISTRY**	
Different types of isomerism. Concept of chirality and optical activity (up to two carbon atoms). Inter conversion of Fischer and Newman representations. Enantiomers, diastereomers, and *meso*compounds. *Threo/ erythro*, D/ L, *cis/ trans*, and E/ Z nomenclature. CIP Rules: *R/S* (only one chiral carbon atoms) nomenclature		
MODULE 3:		**15 Hours**
	GASSEOUS STATE	
Kinetic theory of gases, ideal gas laws based on kinetic theory. Collision in a gas, mean free path, collision diameter, collision number. Behaviour of real gases, the van der Waal's equation. Critical phenomena, critical constants of a gas and their determination, the van der Waals equation and critical state, Principle of corresponding states		
	THERMODYNAMICS	
First Law of thermodynamics. State and path functions, sign convention for heat and work, nature of work. Internal energy, enthalpy, heat changes at constant volume and constant pressure, heat capacities (C_V, C_P) and their relationship for ideal gases. Thermodynamic quantities (*w*, *q*, Δ*U*, Δ*H*) for isothermal and adiabatic reversible expansion of ideal gases and their comparison. Change in internal energy (Δ*U*) and enthalpy (Δ*H*) of chemical reactions, relation between ΔU and ΔH. Concept of entropy, calculation of entropy changes. Gibbs free energy, its measurement and its application in prediction of spontaneity of a process. Variation of heat of reaction with temperature (Kirchhoff's equation).		
3.	**CHEMICAL KINETICS**	
Order and molecularity of chemical reactions. Rate laws for zero, 1^{st} and 2^{nd} order reactions and in general for any n^{th} order reaction. Determination of order of a reaction by half-life and differential methods. Effect of temperature on rate, arrheninus equation. Rate determining step and steady state approximation. Opposing, consecutive and parallel reactions (first order steps only). Enzymatic reactions		
TOTAL LECTURES		**45 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	3	3	2	2						2	3	3	2	3
CO-2	3	2	3	2							2	2	3		2
CO-3	3	2	3	2							2	2	2		2
CO-4	2		2	2							2	2	2		2
CO-5	3	2	3			2					2	2	3		2
CO-6	3	3	3	2	2						2	3	3	2	3

Introduction to Computer Applications (TIU-UCA-MD-T1101)

Program: BSc Biotechnology	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Introduction to Computer Applications	**Subject Code:** TIU-UCA-MD-T1101
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

1. To introduce the basic concepts and functions of computers and their relevance in biotechnology.
2. To develop understanding of number systems and their applications in computing
3. To impart foundational knowledge of programming in C and R languages
4. To familiarize students with software types, flowcharts, and algorithmic approaches.
5. To enhance problem-solving and logical thinking abilities through programming exercises

Course Outcomes:

CO Number	Course Outcome	Knowledge Level
CO1	Describe the basic architecture and functioning of a computer system.	K1
CO2	Convert and perform operations using binary, octal, decimal, and hexadecimal number systems.	K2
CO3	Classify software into system and application software and explain their roles.	K2
CO4	Develop and debug basic programs using R programming languages.	K3

CO5	Demonstrate use of control structures to solve real-life problems programmatically.	K3
CO6	Construct logic-based solutions and represent them using flowcharts and pseudocode.	K4

Course Content

Module	Topics	Hours
1	Definition and Characteristics of Computers, Block Diagram, Types of Computers, Basic Hardware: CPU, RAM, Storage Devices	7
2	Binary, Octal, Decimal, Hexadecimal Systems, Conversions, Binary Arithmetic, 2,Äôs Complement	6
3	System Software vs Application Software, Examples, Booting Process, Programming Languages (Low-level and High-level)	4
4	Flowcharts, Pseudocode, Problem Solving Strategies	8
5	Basics of R, Data Types, Variables, Simple Programs (sequence, selection, iteration), list, function	20
Total Hours		45 hours

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	**3**										**2**	**2**	**2**		
CO-2	**3**	**2**	**2**								**2**	**2**			
CO-3	**3**		**2**								**2**	**2**			
CO-4	**3**	**3**	**3**	**2**	**2**						**2**	**3**	**2**	**2**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**						**2**	**3**	**2**	**2**	**2**
CO-6	**3**	**3**	**3**	**3**	**2**						**2**	**3**	**2**	**2**	**2**

Communicative English- I (TIU-UEN-AEC-S1101)

Program: BSc Biotechnology	**Year, Semester:1st Year, 1st Sem**
Course Title: Communicative English- I	**Subject Code: TIU-UEN-AEC-S1101**
Contact Hours/Week: 2-0-0 (L-T-P)	**Credit: 2**

COURSE OBJECTIVE:

Enable the student to:

Develop English proficiency for clear, precise, and confident workplace communication.
Enhance practical skills in vocabulary, grammar, pronunciation, speaking, and writing.
Apply communication theories to improve professional and interpersonal interactions.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Explain fundamental communication principles and their relevance in workplace interactions.	K2
CO-2:	Apply grammar and language skills to construct precise and coherent spoken and written communication.	K3
CO-3:	Demonstrate fluency in spoken English through pronunciation drills, vocabulary building, and interactive conversations.	K4
CO-4:	Construct well-organized sentences, paragraphs, and linked paragraphs to enhance professional writing	K3
CO-5:	Develop and revise written communication by employing strategies for drafting, editing, and proofreading.	K3
CO-6:	Assess and refine communication skills to ensure clarity, precision, and confidence in workplace interactions.	K4

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO COMMUNICATION**	**5 Hours**
Definition of Communication, Importance of Communication in the Workplace, Introduction to Communication Theory, Elements of Effective Communication, Barriers to Communication, Verbal and Non-Verbal Communication, Role of Culture in Communication.		
MODULE 2:	**LANGUAGE AND GRAMMAR SKILLS**	**5 Hours**
Fundamentals of English Grammar, Sentence Structure and Syntax, Parts of Speech, Tenses and their Usage, Common Errors in Grammar, Punctuation and Mechanics, Effective Use of Vocabulary, Word Formation and Usage, Formal vs. Informal Language.		
MODULE 3:	**SPEAKING SKILLS**	**5 Hours**
Principles of Effective Speaking, Pronunciation Drills, Sounds of English: Vowels and Consonants, Stress and Intonation, Developing Conversational Skills, Speaking with Clarity and Confidence, Public Speaking Basics, Expressing Opinions and Arguments, Active Listening and Response.		
MODULE 4:	**WRITING SKILLS**	**5 Hours**
The Writing Process: Planning, Drafting, Revising, Editing, Writing Effective Sentences and Paragraphs, Paragraph Development and Coherence, Formal and Informal Writing Styles, Writing Emails and Workplace Documents, Writing Reports and Memos, Common Writing Errors and How to Avoid Them		

MODULE 5:	**PRACTICAL LANGUAGE APPLICATION**	**5 Hours**
Building Vocabulary through Context, Word Choice and Precision, Constructing Grammatically Correct Sentences, Exercises in Sentence Formation, Pronunciation Drills and Accent Neutralization, Role-Plays and Dialogues, Group Discussions and Debates, Writing and Structuring Paragraphs, Linking Paragraphs for Coherent Writing.		
MODULE 6:	**PROFESSIONAL COMMUNICATION IN THE WORKPLACE**	**5 Hours**
Workplace Communication Etiquette, Business Correspondence, Writing Professional Emails, Preparing Presentations, Communicating in Meetings, Handling Workplace Conversations, Persuasive and Negotiation Skills, Overcoming Communication Barriers, Strategies for Effective Workplace Communication.		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	**2**		**2**					**3**	**2**	**2**	**2**	**2**			
CO-2	**2**		**2**					**3**		**2**	**2**	**2**			
CO-3	**2**		**2**	**2**				**3**	**2**	**2**	**2**	**3**			
CO-4	**2**		**2**	**2**				**3**		**2**	**2**	**3**			
CO-5	**2**		**2**	**2**				**3**		**2**	**2**	**3**			
CO-6	**2**		**2**	**2**				**3**	**2**	**2**	**2**	**3**			

Environmental Science (TIU-UBT-CVA-T1101)

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 1st Sem.
Course Title: Environmental Science	**Subject Code:**TIU-UBT-CVA-T1101
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit: 2**

Course Objective:

1. Develop a Foundational Understanding of Environmental Science

Introduce students to the scope, importance, and need for environmental education, emphasizing sustainability and sustainable development.

2. **Explore Ecosystem Dynamics and Biodiversity Conservation**

Provide knowledge about ecosystem structure, energy flow, nutrient cycling, ecological interactions, and biodiversity conservation, including threats and protection strategies.

3. **Analyze Environmental Issues and Sustainable Solutions**

Examine major environmental challenges such as pollution, climate change, biodiversity loss, and waste management while evaluating their impacts and potential mitigation strategies.

COURSE OUTCOME:

CO No.	Course Outcome	**Knowledge Levels**
CO1	Explain the scope and importance of environmental science, sustainability, and sustainable development.	K2
CO2	Describe ecosystem structure, food chains, food webs, energy flow, nutrient cycling, and ecological succession.	K1
CO3	Analyze biodiversity at genetic, species, and ecosystem levels, identify biodiversity hotspots, and assess conservation strategies.	K4
CO4	Assess environmental issues such as pollution, climate change, ozone depletion, and acid rain, and their impacts on human communities.	K3
CO5	Investigate human-wildlife conflicts, biodiversity conservation, and policies related to tribal rights and nature reserves in India.	K3, K4
CO6	Evaluate waste management strategies, including e-waste and biomedical waste, and analyze environmental disasters and their consequences.	K4

COURSE CONTENT:

MODULE 1:		**5 Hours**
Scope and introduction to environmental science- environmental studies; Scope and importance; the need for environmental education. Concept of sustainability and sustainable development.		
MODULE 2:		**8 Hours**
What is an ecosystem? Structure: food chains, food webs and function of ecosystem:Energy flow in an ecosystem, nutrient cycle and ecological succession. Ecological Interactions. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)		
MODULE 3:		**8 Hours**
Biodiversity and Conservation. - Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots b. India as a mega-biodiversity nation; Endangered and endemic species of India c. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlifeconflicts, biological invasions; Conservation of biodiversity:In-situ and Ex-situ conservation of biodiversity. d. Nature reserves, tribal populations and rights (Niyamgiri-Vedanta, POSCO), and human wildlife conflicts in Indian context (Sundarban-Human-Tiger encounters). e. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.		

MODULE 4		9 hours
environmental challenges and issues: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. b. Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture c. nuclear hazards and human health risks (Chernobyl, 3 mile Island, Daiichi- Fukushima) d. Solid waste management: Control measures of urban and industrial waste,specialreferenceto e-waste, Biomedical waste. Pollution Tragedies: Love canal, Bhopal Gas, Endosulfan, Minamata and Flint water		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	2		2			3	2	2		2	2	3			
CO-2	2		2			3					1	2			
CO-3	2	2	3		2	3	2			3	2	3	1	2	
CO-4	2	2	3		2	3	2			3	2	3	1	2	
CO-5	2	2	2		2	3	3		1	3	2	3	2	2	
CO-6	2	2	3		3	3	2		1	3	2	3	2	2	1

BIOCHEMISTRY AND METABOLISM LAB (TIU-UBT-MJ-L11101)

Program: B. Sc. in Biotech	**Year, Semester: 1st**Yr., 1st Sem.
Course Title: BIOCHEMISTRY AND METABOLISM LAB	**Subject Code:** TIU-UBT-MJ-L11101
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 2**

COURSE OBJECTIVE:

Enable the student to:

To introduce students to fundamental biochemical laboratory techniques, including enzyme activity assays, colorimetry, and chromatography, for analyzing biological molecules.

To develop an understanding of enzyme kinetics by studying the effects of pH, temperature, substrate concentration, and inhibitors on enzyme activity.

To equip students with practical skills in biomolecule estimation, buffer preparation, and qualitative biochemical tests for carbohydrates, lipids, and proteins, enabling accurate biochemical analysis.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Recollect the fundamental principles of enzyme activity and demonstrate the optimal conditions required for enzymatic reactions.	K1
CO-2:	Explain the impact of pH and temperature on enzyme kinetics using salivary amylase as a model system.	K2
CO-3:	Apply enzyme kinetics principles by determining pH optima, temperature optima, Km, Vmax, and the effect of inhibitors on enzyme activity.	K3
CO-4:	Analyze biochemical parameters such as blood glucose levels using the glucose oxidase method and interpret the results.	K4
CO-5:	Perform colorimetric estimations of biomolecules (proteins, carbohydrates) and verify Beer's law to understand the relationship between absorbance and transmission.	K3
CO-6:	Evaluate different biochemical separation techniques such as buffer preparation, paper chromatography for amino acid separation, and qualitative tests for macromolecules	K4

Course Content

Experiment	
To study activity of any enzyme under optimum conditions.	
To study the effect of pH, temperature on the activity of salivary amylase enzyme	
Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.	
Estimation of blood glucose by glucose oxidase method	**TOTAL (56 HOURS)**
Principles of Colorimetry**: (i)** Verification of Beer's law, estimation of protein. **(ii)** To study relation between absorbance and % transmission..	
Preparation of buffers.	
Separation of Amino acids by paper chromatography.	

Separation of Amino acids by paper chromatography.	

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3				2						2	2	2		2
CO-2	3		2		2						2	2	2		2
CO-3	3	3	3		3						3	3	3	2	3
CO-4	3	2	3		3					2	3	3	3	3	3
CO-5	3	2	3		3						3	3	3	2	3
CO-6	3	3	3	2	3				2	2	3	3	3	2	3

Chemistry Lab (TIU-UCH-MI-L11101**)**

Program: B.Sc. Biotechnology	**Year, Semester:** Ist year., 1st Sem.
Course Title: Chemistry Lab	**Subject Code**: TIU-UCH-MI-L11101
Contact Hours/Week: 0-0-2 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE:

Enable the student to:

1.Understand the safety protocol and adhere to the best laboratory practical purpose

2.Understand the chemical nature of the hazardous chemicals.

3.Understand the basic analytical technique

4.Apply the basic analytical technique for real time analysis

5.Analyze the result obtained post performance of the experiment

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	**Understand** the safety protocols, and practice the best practices inside a chemistry lab.	K2
CO-2:	**Understand** the nature of various types of reagents and their handling as well as storage.	K2
CO-3:	**Analyze** the functional groups present in organic molecules by simple reactions	K4

CO-4:	**Understand** the basics of analyzing various types of organic compounds and their properties.	K4
CO-5:	**Understand** the basic analytical techniques, such as preparation solutions of desired strength, standardization of solutions and analysis of concentration of the species (chemicals, metal ions, active ingredients etc.) present in unknown samples using titrimetric and volumetric method.	K2
CO-6:	**Apply** the basic analytical techniques, such as preparation solutions of desired strength, standardization of solutions, and analysis of concentration of the species in the real time analysis.	K3

COURSE CONTENT:

EXPERIMENT-1:	Qualitative Analysis (Organic and Inorganic):	Total duration -30 hours
(i) Detection of elements (X, N, S) in organic compounds. [X = Cl, Br, I] (ii) Detection of functional groups: COOH, C=O, CHO, Ar─OH, Ar─NH_2, Ar─NO_2, $CONH_2$ (iii) *Qualitative Inorganic Mixture Analysis:* Anions, interfering anions, cations and insolubles.		
EXPERIMENT-2:	Quantitative Analysis (Physical and Volumetric):	
Standardization of $Na_2S_2O_3$ solution against standard $K_2Cr_2O_7$ solution. (ii) Estimation of available chlorine in bleaching powder. (iii) Determination of reaction rate of iodide with hydrogen peroxide in acidic medium (iodine clock reaction		

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3				2					2	3	2	2		2
CO-2	3				2					1	2	2	2		2
CO-3	3	2	3		3						3	3	3	2	3
CO-4	3	2	3		3						3	3	3	2	3
CO-5	3	2	2		3					2	3	3	3	2	3
CO-6	3	3	3	2	3	1			2	2	3	3	3	2	3

Instrumentation Technique-I (TIU-UBT-SEC-T1101)

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 1st Sem.

Course Title: Instrumentation Technique-I	**Subject Code:**TIU-UBT-SEC-T1101
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

Course Objective:

1. Develop Fundamental Laboratory Skills

Introduce students to essential laboratory techniques, including aseptic methods, microscopy, centrifugation, and spectrophotometry, to ensure accuracy and precision in biotechnological research.

2. Understand Molecular Biology Techniques

Provide knowledge of nucleic acid isolation, gel electrophoresis, PCR, restriction digestion, ligation, and blotting techniques, with a focus on their applications in genetic analysis and biotechnology.

3.Explore Biochemical and Analytical Techniques

Familiarize students with chromatography, protein purification, and enzyme assays, enabling them to analyze biomolecules and study biochemical processes relevant to biotechnology applications.

COURSE OUTCOME :

CO No.	Course Outcome	
CO1	Demonstrate knowledge of aseptic techniques, sterilization methods, and media preparation for microbiological and biochemical experiments.	K1,K2
CO2	Perform microscopy techniques, including sample preparation, staining, and visualization using different types of microscopes.	K3
CO3	Utilize centrifugation and spectrophotometry techniques to analyze biomolecules and biochemical samples.	K3
CO4	Execute molecular biology techniques such as nucleic acid isolation, gel electrophoresis, PCR, for DNA and protein analysis.	K3 , K4
CO5	Apply chromatography and protein purification techniques for biomolecule separation and characterization in biotechnological applications.	K3 , K4
CO6	Conduct enzyme assays to determine enzyme kinetics and biochemical reactions using spectrophotometric and fluorometric methods.	K4

COURSE CONTENT :

MODULE 1:		**15 Hours**
Basic Laboratory Techniques **Aseptic Techniques:** Principles of aseptic technique Sterilization methods (autoclave, dry heat, filtration)		

Media preparation and sterilization

Microscopy:

Types of microscopes (light, phase contrast, fluorescence, electron)

Sample preparation and staining techniques

Microscopy techniques (bright field, dark field, phase contrast, fluorescence)

Centrifugation:

Principles of centrifugation

Types of centrifuges (low speed, high speed, ultracentrifuge)

Applications of centrifugation in biotechnology

Spectrophotometry:

Principles of spectrophotometry

Types of spectrophotometers (UV-visible, infrared)

Applications of spectrophotometry in biotechnology

MODULE 2:		**20 Hours**

Nucleic Acid Isolation:

Methods for DNA and RNA isolation

Purification techniques (column chromatography, precipitation)

Gel Electrophoresis:

Principles of gel electrophoresis

Types of gels (agarose, polyacrylamide)

Applications of gel electrophoresis (DNA, RNA, protein)

Polymerase Chain Reaction (PCR):

Principles of PCR

PCR components and optimization

Applications of PCR (amplification, cloning, sequencing)

Blotting Techniques:

Southern blotting, Northern blotting, Western blotting

Applications in molecular biology

MODULE 3:		**10 Hours**

Biochemical Techniques

Chromatography:

Principles of chromatography

Types of chromatography (column, thin layer, gas, liquid)

Applications in biotechnology (protein purification, metabolite analysis)

Protein Purification Techniques:

Dialysis, ultrafiltration, affinity chromatography, ion exchange chromatography, gel filtration chromatography

Enzyme Assays:

Principles of enzyme assays

Types of enzyme assays (spectrophotometric, radiometric, fluorometric)

Applications in biotechnology (enzyme kinetics, product analysis)

TOTAL LECTURES	45 Hours

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3				3					2	3	2	3	2	2
CO-2	3	2	2		2					1	3	2	3	2	3
CO-3	3	3	3	2	3					1	3	3	3	3	3
CO-4	3	3	3	2	3					1	3	3	3	3	3
CO-5	3	3	3	2	3					1	3	3	3	3	3
CO-6	3	3	3	2	3					2	3	3	3	3	3

Introduction to Microbiology (TIU-UBT-MJ-T12101**)**

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 2nd Sem.
Course Title:Introduction to Microbiology	**Subject Code:** TIU-UBT-MJ-T12101
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objectives:

1. Equip students with a foundational understanding of the diversity, structure, and function of microorganisms.
2. Explore the principles and techniques used for the cultivation, identification, and manipulation of microbes.
3. Develop an appreciation for the role of microorganisms in various fields like healthcare, industry, and the environment.
4. Foster critical thinking and problem-solving skills in the context of microbiological applications.

COURSE OUTCOME :

CO No.	Course Outcome	Knowledge levels
CO1	Explain the history, evolution, and classification of microorganisms, including microbial diversity and phylogeny.	K1 , K2
CO2	Describe the morphology, structure, and characteristics of prokaryotic and eukaryotic microorganisms, including viruses.	K2
CO3	Demonstrate knowledge of microbial cultivation, nutritional categories, and methods for isolation and preservation of	K2, K3

	microorganisms.	
CO4	Analyze microbial growth, metabolism, and genetic mechanisms such as transformation, transduction, and conjugation.	K3 K4
CO5	Evaluate methods for controlling microorganisms using physical, chemical, and chemotherapeutic agents, and understand microbial roles in biogeochemical cycles.	K3 K4
CO6	Assess microbial applications in water and food microbiology, including bacterial pollutants, foodborne infections, and food preservation techniques.	K4

COURSE CONTENT :

MODULE 1:		**15 Hours**
Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.		
MODULE 2:		**10 Hours**
Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation and preservation of microbial culture.		
MODULE 3:		**15 Hours**
Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways, Mutation, Bacterial Reproduction: Transformation, Transduction and Conjugation.		
Module 4		**20 hours**
Control of Microorganisms: By physical, chemical and chemotherapeutic Agents, Nitrogen, Phosphorus, Carbon sulphur cycle, Water Microbiology: Bacterial pollutants of water, coliforms and non-coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food-borne infections and intoxications, as well as the preservation of various types of foods. Fermented Foods.		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**

CO-1	3		2				1			1	2	2	2	1	1
CO-2	3		2							1	2	2	2	1	1
CO-3	3	2	2		2					2	2	2	3	2	3
CO-4	3	3	3	2	3					2	3	3	3	3	3
CO-5	3	3	3	2	3	2				2	3	3	3	3	3
CO-6	3	2	3	2	3	3				2	3	3	3	3	3

Chemistry-II (TIU-UCH-MI-T12101**)**

Program: B.Sc. Biotechnology	**Year, Semester:** Ist year., 2nd Sem.
Course Title: Chemistry-II	**Subject Code**: TIU-UCH-MI-T12101
Contact Hours/Week: 3-0-0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

Enable the student to:

Understand the basic concept of structure of atom, covalent bonding, non covalent bonding thermodynamics, chemical kinetics ionic equilibria, nomenclature, stereochemistry, structures, reactivity, and mechanism of chemical reactions.

Apply the concept of thermodynamics, chemical kinetics, and ionic equilibria, in the relevant advanced and emerging field of biotechnological studies.

Apply the concept of covalent and non covalent bonding, in acquiring information regarding the metals used in any process of biotechnological system.

Remember the knowledge of stereochemistry and reaction mechanism in understanding the glimpse of the reaction pathways involved in the biotechnology process.

Understand the concept of various types of bonding, energy distributions in atomic and molecular orbital makes the student easier to understand the technology based on them.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	**Understand** the underlying concepts of development of periodic table and learn to predict properties of elements by going through periodic variations of properties across the period and down the group. They will be able to use the periodic table to rationalize similarities and differences of elements, including physical and chemical properties and reactivity.	K2
CO-2:	**Understand** the nature of metal-ligand bonding in complexes and prediction of various properties of complexes by ligand field theory. The will also be able to explain the structure,	K2

	spectral and magnetic properties of coordination complexes using the theory.	
CO-3:	**Analyze**the physical and chemical properties of organic molecules to predict their reactivity, nature of reactive intermediates, and various types of reaction mechanisms.	K2
CO-4:	**Analyze** several physical parameters controlling the organic transformations and comprehend the chemistry of numerous functionalized organic compounds.	K1
CO-5:	**Understand** two important properties of liquids which are viscosity, surface tension. They will also learn several factors that affect viscosity and surface tension of liquid and methods of their measurements.	K2
CO-6:	**Remember**the knowledge of analytical chemistry by learning nature of various types of electrolytes (acid, base, salt) in solution, measurement of their strength, preparation of buffers etc.	K3

COURSE CONTENT:

MODULE 1:		**15 Hours**
1.	**PERIODIC TRENDS AND PROPERTIES**	
(i) General idea about modern periodic table, Definition and trends of variation of atomic and ionic radii, ionization energy, electron affinity and electro negativity, Prediction of chemical behaviour of elements and compounds. **(ii) Comparative study of p-block elements:** Electronic configuration, common oxidation states, inert pair effect. Important compounds and their properties and reactivity's		
2	**COORDINATION CHEMISTRY**	
Werner's coordination theory. Structural and stereoisomerism in complexes, Drawbacks of VBT.		
3	**VBT AND LIGAND FIELD THEORY**	
Valence Bond Theory (VBT), inner and outer orbital complexes. Ligand field effect, splitting of d orbitals in octahedral and tetrahedral complexes, Factors affecting the magnitude of splitting, spectrochemical series, crystal field stabilization energy (CFSE). Distortion in octahedral and tetrahedral geometries, Jahn-Teller theorem. Splitting of d orbitals in square planar complex.		
MODULE 2:		**15 Hours**
1.	**SUBSTITUTION ELIMINATION AND ADDITION REACTIONS**	
Carbocations, non-classical carbocations, carbanions, carbon radicals, generation and stability, structure and electrophilic / nucleophilic behaviour of reactive intermediates (elementary idea). Nucleophilic substitutions: S_N1, S_N2 and S_Ni reactions. Eliminations: E1, E2 and E1cB reactions (elementary mechanistic aspects), Saytzeff and Hofmann eliminations. Electrophilic and nucleophilic addition reactions of unsaturated hydrocarbons and carbonyls		
2.	**AROMATIC ELECTROPHILIC SUBSTITUTION**	
Mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts (alkylationa and acylation) reactions. Effects of substituents on orientation and reactivity.		
3.	**PHYSICAL ORGANIC CHEMISTRY**	
Free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change *via* BDE,		

intermolecular & intramolecular reactions. Rate constant and free energy of activation, free energy profiles for one-step, and two-step reactions. Catalyzed reactions, principle of microscopic reversibility. Hammond's postulate. Halogenation of alkanes, mechanism (with evidence) and stereo chemical features. Reactivity-selectivity principle in the light of Hammond's postulate.		
MODULE 3:		**15 Hours**
	LIQUID STATE	
Surface tension of liquids - capillary action, experimental determination of surface tension, temperature effect on surface tension. Viscosity of liquids, experimental determination of viscosity coefficient, its variation with temperature		
	IONIC EQUILIBRIA	
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases. pH scale. Common ion effect. Salt hydrolysis, calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts, applications of solubility product principle.		
3.	**BIOMOLECULES**	
Amino acids, peptides and proteins: Amino acids (Nature, Chemical reaction, Detection and Configuration); Peptides (The Peptide Linkage, Structure of Polypeptides); Proteins (General Characteristics, Classification, Structure). Carbohydrate: Introduction, occurrence, classification, constitution of glucose, osazone formation. Brief descriptions of lipids, fats and nucleic materials (DNA, RNA).		
TOTAL LECTURES		**45 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3	2	2							1	2	2	2		1
CO-2	3		2							1	2	2	2		1
CO-3	3	2	3		2					2	3	2	3	2	2
CO-4	3	2	3	2	2					2	3	2	3	2	2
CO-5	3		2			2				1	2	2	2		2
CO-6	3	2	3		2					2	3	2	3	2	3

Data Science (TIU-UBT-MD-T1202)

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 2ND Sem.

Course Title: Data Science	**Subject Code:**TIU-UBT-MD-T1202
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit: 3**

Course Objectives:

1. To introduce students to the fundamental concepts of bioinformatics, biocomputing, and biological databases, including their structure, retrieval methods, and applications.
2. To equip students with the knowledge and skills required for sequence analysis, structural bioinformatics, and computational techniques for studying biological macromolecules.
3. To provide an understanding of advanced bioinformatics techniques, including protein structure prediction, genome annotation, and AI/ML applications in bioinformatics.

Course Outcomes (COs)

CO No.	Course Outcome	Knowledge Levels
CO1	Define and explain the fundamentals of bioinformatics, biocomputing, and the role of AI, ML, and data science in biological data analysis.	K1,K2
CO2	Identify and retrieve biological data from various databases (FASTA, GenBank, PDB) and understand data storage formats.	K2, K3
CO3	Perform sequence analysis using pairwise/multiple sequence alignment, BLAST, FASTA, and scoring matrices (PAM, BLOSUM) for phylogenetic studies.	K3
CO4	Analyze protein structures, including folding mechanisms and molecular docking, using computational tools.	K3,K4
CO5	Evaluate protein structure prediction methods such as Chou-Fasman, homology modelling, and AI-based tools like AlphaFold.	K4
CO6	Apply bioinformatics approaches for genome annotation, gene prediction, and promoter identification in prokaryotic and eukaryotic genomes.	K3, K4

COURSE CONTENT :

MODULE 1:		**15 Hours**
Introduction to Bioinformatics, Biological Databases and Basics of AI, ML and Datacience Definition and scope of bioinformatics, similarities and differences between computational biology and bioinformatics, and the concept of biocomputing. Historical perspective with key milestones in bioinformatics. Overview of major types of biological databases, methods for retrieving and analyzing biological data, and understanding data formats such as FASTA, GenBank, and PDB. The role of artificial intelligence, machine learning, and data science in bioinformatics and their importance in managing, analyzing, and interpreting biological data.		
MODULE 2:		**10 Hours**

Sequence Analysis Basics of nucleotide and protein sequences, pairwise and multiple sequence alignment techniques, phylogeny, heuristic search tools like BLAST and FASTA, scoring matrices (PAM and BLOSUM), and concepts of sequence similarity, identity, and homology.		
MODULE 3:		**10 Hours**
Structural Bioinformatics Overview of amino acid types, protein structures (primary, secondary, tertiary, and quaternary), protein folding mechanisms, and the fundamentals of docking and molecular dynamics simulations.		
Module 4		**10 hours**
Advanced Techniques in Bioinformatics Protein structure prediction techniques including the Chou-Fasman algorithm, homology modeling, and threading. Discussion of 3D structure prediction methods like AlphaFold, as well as in silico approaches for genome annotation, including gene and promoter prediction for prokaryotes and eukaryotes, along with performance evaluation methods.		
TOTAL LECTURES		**45 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	**3**	**2**	**2**	**2**	**1**			**2**	**1**	**1**	**2**	**2**	**3**	**2**	**2**
CO-2	**3**	**2**	**3**		**2**			**2**		**1**	**2**	**2**	**3**	**2**	**3**
CO-3	**3**	**3**	**3**		**2**			**2**	**1**	**1**	**2**	**3**	**3**	**2**	**3**
CO-4	**3**	**3**	**3**	**2**	**3**			**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO-5	**3**	**2**	**3**	**2**	**3**			**2**		**2**	**3**	**3**	**3**	**3**	**3**
CO-6	**3**	**3**	**3**	**2**	**3**			**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

Communicative English- II (TIU-UEN-AEC-S1201)

Program: BSc Biotech	**Year, Semester:1st Year, 2nd Sem**
Course Title: Communicative English- II	**Subject Code:TIU-UEN-AEC-S1201**
Contact Hours/Week: 2-0-0 (L-T-P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

Develop fluency in spoken and written English for clear, precise, and confident communication.

Train in formal writing, reports, proposals, and multimedia presentations.

Strengthen people skills, time management, and analytical reading for workplace success.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	**Explain** fundamental communication principles and **assess** their relevance in workplace interactions.	K2
CO-2:	**Apply** grammar and language skills to **construct** precise and coherent spoken and written communication	K3
CO-3:	**Demonstrate** fluency in spoken English through **practicing** pronunciation drills, **developing** vocabulary, and **engaging** in interactive conversations.	K4
CO-4:	**Construct** well-organized sentences and paragraphs to **enhance** professional writing.	K3
CO-5:	**Develop** and **revise** written communication by **employing** strategies for drafting, editing, and proofreading	K3
CO-6:	**Assess** and **refine** communication skills to **ensure** clarity, precision, and confidence in workplace interactions.	K4

Course conte

MODULE 1:	**COMMUNICATION THEORY AND WORKPLACE DYNAMICS**	**5 Hours**
Definition of Communication, Communication Models, Workplace Communication Strategies, Effective Messaging, Organizational Communication, Cultural Communication, Verbal and Non-Verbal Cues, Barriers to Communication, Interpersonal and Group Communication		
MODULE 2:	**ADVANCED LANGUAGE AND GRAMMAR PROFICIENCY**	**5 Hours**
Morphology and Syntax, Sentence Structuring, Advanced Grammar Rules, Tense Modulation, Phrasal Verbs, Modifiers, Cohesion and Coherence, Lexical Resource, Semantics, Formal vs. Informal Register		
MODULE 3:	**STRATEGIC SPEAKING AND ORAL PROFICIENCY**	**5 Hours**
Phonetics and Phonology, Pronunciation Refinement, Stress and Intonation, Articulation and Clarity, Persuasive Speaking, Argumentation and Debate, Spontaneous Speaking, Interview Techniques, Business Pitches, Active Listening Strategies		
MODULE 4:	**PROFESSIONAL AND TECHNICAL WRITING**	**5 Hours**
Writing Process Methodologies, Text Structuring, Precision in Writing, Report Writing, Business Proposals, Formal Correspondence, Executive Summaries, Editing and Proofreading, Technical Documentation, Press Releases, Persuasive and Analytical Writing		
MODULE 5:	**APPLIED LANGUAGE AND COMMUNICATION EXERCISES**	**5 Hours**
Lexical Expansion, Idiomatic Expressions, Context-Based Learning, Grammar in Context, Role-Plays and Simulations, Speech Analysis, Storytelling Techniques, Collaborative Writing,		

Dialogues, Workplace Case Studies		
MODULE 6:	**CORPORATE COMMUNICATION AND LEADERSHIP SKILLS**	**5 Hours**
Professional Etiquette, Negotiation Tactics, Conflict Resolution, Crisis Communication, Leadership and Persuasion, Presentation Design, Cross-Cultural Communication, Media and Public Relations, Digital Communication Ethics, High-Stakes Conversations		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	2	2	3	2			2	3	2	2	2	3			
CO-2	2	2	3	2				3	2	2	2	3			
CO-3	2	1	2	2			2	3	3	2	2	3			
CO-4	2	2	3	2				3	2	2	2	3			
CO-5	2	2	3	2				3	2	2	2	3			
CO-6	2	2	3	2			2	3	3	3	3	3			

Industrial Fermentation (TIU-UBT-SEC-S1201)

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 2nd Sem.
Course Title: Industrial Fermentation	**Subject Code:TIU-UBT-SEC-T1201**
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

Course Objectives:

1. To introduce the concepts and scope of industrial fermentation and microbial processes.
2. To familiarize students with microbial growth, bioreactor types, and process optimization.
3. To explore the role of fermentation in producing value-added products.
4. To understand strain improvement, product recovery, and scale-up challenges.

Course Outcomes:

CO Code	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the basic concepts and classifications of industrial fermentation.	K1

CO2	Explain microbial growth phases, metabolic pathways, and fermentation process types.	K2
CO3	Apply microbial techniques for inoculum preparation and fermentation process setup.	K3
CO4	Analyze strain improvement strategies and evaluate environmental control in bioreactors.	K4
CO5	Evaluate the design of industrial fermentations for products like wine, antibiotics, and biofuels.	K4
CO6	Evaluate case studies and suggest improvements in industrial fermentation processes based on data analysis.	K4

Course Content:

Module	**Title**	**Course Content**	**Hours**	**Knowledge Level**
Module 1	Fundamentals of Industrial Fermentation	Definition, history, and scope of industrial fermentation; Classification of fermentation (batch, fed-batch, continuous); Microbial growth kinetics (lag, log, stationary, death phases); Specific growth rate, yield coefficients.	10 Hours	K1–K2
Module 2	Microbial Metabolism & Product Formation	Metabolic pathways in industrial microbes; Primary vs. secondary metabolites; Fermentation products: enzymes, alcohols, acids, antibiotics, etc.; Role of *Acetobacter*, *Lactobacillus*, *Saccharomyces*, *Penicillium*	10 Hours	K2–K3
Module 3	Bioprocess Design and Optimization	Bioreactor types (stirred tank, airlift, packed bed); Inoculum preparation; Aerobic vs anaerobic fermentation; Oxygen transfer, pH, temperature, and nutrient optimization	10 Hours	K2–K4
Module 4	Strain Improvement and Scale-Up	Strain selection and genetic improvement techniques; Recombinant strains; Media composition and scale-up strategies; Sterilization and contamination control	7 Hours	K3–K4
Module 5	Industrial Applications and Case Studies	Case studies: Antibiotic production (*Penicillin*), Wine, Bread, Bioethanol, Biodiesel; Industrial fermentation economics; Current trends in	8 Hours	K4–K4

		fermentation tech		

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3	2	2								2	2	3	2	2
CO-2	3	3	2	2							2	2	3	2	3
CO-3	3	3	3	2	3				2	2	2	3	3	3	3
CO-4	3	3	3	3	3				2	2	2	3	3	3	3
CO-5	3	3	3	3	3	2		2	2	2	2	3	3	3	3
CO-6	3	3	3	3	3	2		2	2	2	3	3	3	3	3

Artificial Intelligence (AI) (TIU-UBT-CVA-T1201)

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 2nd Sem.
Course Title: Artificial Intelligence (AI)	**Subject Code:** TIU-UBT-CVA-T1201
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit: 2**

Course Objective

To introduce basic concepts and terminology related to Artificial Intelligence.

To explain AI approaches like state-space search, constraint satisfaction, and genetic algorithms.

To build an understanding of neural networks and AI applications in biology and biotechnology.

Course Outcomes:

CO No.	**Course Outcome Statement**	**Knowledge Level**
CO1	Understand the concepts of AI and the role of agents in decision-making.	K2
CO2	Apply uninformed and informed search strategies to solve state-space problems.	K3
CO3	Analyze the design of genetic algorithms and their applications in optimization problems.	K4
CO4	Describe structure, functions, and applications of artificial neural networks.	K2
CO5	Illustrate constraint satisfaction problems using configuration search	K3

	approaches.	
CO6	Solve fundamental AI problems using flow diagrams, graphs, and problem-solving strategies.	K4

Course Content:

Module	**Title**	**Topics Covered**
Module 1	Foundations of Artificial Intelligence	Definition and scope of AI, types of agents, problem formulation, state space graph vs search tree, production systems
Module 2	Search Strategies in AI	Uninformed search: BFS, DFS, Depth Limited Search, Iterative Deepening Search; Informed search: Heuristics, A*; Bidirectional search
Module 3	Genetic Algorithms & Constraint Satisfaction	Configuration search problems, Genetic Algorithm: Crossover and Mutation, Flow diagrams, Termination conditions, N-Queen problem
Module 4	Artificial Neural Networks	Structure and components of ANN, Feedforward and Feedback networks, Activation functions, Applications in AI
Module 5	Problem Solving and Applications	Solving classical problems: 8 puzzle, Missionaries & Cannibals; AI application examples; Neural network tasks
Module 6	Hands-on Practice & Evaluation	Practice in search strategy design, flow diagrams for GAs, ANN structure drawing, quiz, assignment, viva

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3		2					2			2	2	3		
CO-2	3	3	3	2	2						2	3	3	2	
CO-3	3	2	3	3	3						2	3	3	3	2
CO-4	3		2		2			2				2	3	2	
CO-5	3	2	3	2	2							2	3	2	
CO-6	3	3	3	2	3			2			2	3	3	3	2

Program: B. Sc. Biotechnology	**Year, Semester: 1st** Yr., 2nd Sem.
Course Title: Microbial Physiology Lab	**Subject Code:** TIU-UBT-MJ-L12101
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 2**

Course Objectives:

1. Provide students with hands-on experience in fundamental microbiological techniques.
2. Develop competency in aseptic techniques for safe handling of microorganisms.
3. Equip students with skills for isolation, cultivation, identification, and characterization of microbes.

COURSE OUTCOME :

CO No.	Course Outcome	Knowledge Level (K1–K4)
CO1	Identify and demonstrate the working principles of microbiology laboratory equipment.	K1,K2
CO2	Prepare culture media and explain its role in microbial growth and isolation.	K2,K3
CO3	Perform bacterial isolation using streak plating and analyze colony morphology.	K3
CO4	Conduct serial dilution and spread plating techniques to quantify bacterial populations.	K3
CO5	Perform Gram staining and interpret bacterial cell wall differences based on staining results.	K3 ,K4
CO6	Analyze bacterial growth patterns using a bacterial growth curve and biochemical characterization techniques.	K4

Course Content:

Module	Title	Course Content	Total
Experiment 1	Introduction to Microbiology Lab Equipment Demonstration and understanding of laminar flow hood, autoclave, incubator, hot air oven, microscope, etc.		**60 Hours**
Experiment 2	Culture Media Preparation Preparation of nutrient broth, agar media, and selective media; media pouring techniques and pH adjustment		
Experiment 3	Bacterial Isolation Techniques		

	Isolation of pure bacterial colonies using streak plating method	
Experiment 4	Quantification of Microbial Population Serial dilution and spread plate method for viable bacterial count	
Experiment 5	Bacterial Staining Technique Gram staining procedure, observation under microscope, and interpretation of results	
Experiment 6	Microbial Growth Measurement Determination of bacterial growth curve using spectrophotometry; plotting of growth phases	
Experiment 7	Biochemical Characterization of Bacteria IMViC tests, catalase, oxidase, starch hydrolysis, and other relevant biochemical tests	

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3		2						2	2	2	2	3		2
CO-2	3	2	2		2						2	2	3	2	3
CO-3	3	3	3	2	2						3	2	3	3	3
CO-4	3	3	3	2	3						2	3	3	3	3
CO-5	3	2	3		2					2	2	2	3	2	2
CO-6	3	3	3	2	3			2	2	2	3	3	3	3	3

Chemistry Lab (TIU-UCH-MI-L12101)

Program: B.Sc. Biotechnology	**Year, Semester:** Ist year., 2nd Sem.
Course Title: Chemistry Lab	**Subject Code**: TIU-UCH-MI-L12101
Contact Hours/Week: 0-0-2 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE:

Enable the student to:

Understand the safety protocol and adhere to the best laboratory practical purpose

Understand the chemical nature of the hazardous chemicals.

Create an experimental procedure to perform reactions in order to synthesize important organic compounds and metal complexes.

Understand the characterization techniques such as melting point, UV-visible absorption etc.

Understand the basic analytical tool in order to prepare the solutions required for various types of titrimetric analysis

Apply the knowledge of analytical technique for the determination of exact strength of the solutions by using a primary standard.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	**Understand** the safety protocols, and practice the best practices inside a chemistry lab.	K2
CO-2:	**Understand** the nature of various types of reagents and their handling as well as storage.	K2
CO-3:	**Create** an experimental procedure and perform reactions to synthesize important organic compounds and metal complexes	K4
CO-4:	**Understand** the preliminary characterization techniques such as melting point, UV-visible absorption etc.	K2
CO-5:	**Understand** the basic analytical techniques, such as Prepare the solutions required for various types of titrimetric analysis and determination of exact strength of the solutions by using a primary standard.	K2
CO-6:	**Apply** the analytical skills to estimate quantitatively various metal ions, inorganic elements, active ingredients etc. present in samples of various types.	K3

COURSE CONTENT

EXPERIMENT-1: Synthesis of metal complex Synthesis of a series of metal complexes (with ligands of varying ligand field strength), electronic spectral interpretation and calculation of various ligand-field parameters. Synthesis of metal complexes and determination of melting point, UV-vis absorption.	Total 30 hours
EXPERIMENT-2: Preparation of Inorganic Compounds Standardization of $Na_2S_2O_3$ solution against standard $K_2Cr_2O_7$ solution. (ii) Estimation of available chlorine in bleaching powder. (iii) Determination of reaction rate of iodide with hydrogen peroxide in acidic medium (iodine clock reaction	

EXPERIMENT-3: Preparation of Organic Compounds: m-dinitrobenzene, Acetanilide, Bromo acetanilide, Oxidation of primary alcohols-Benzoic acid from benzyl alcohol. Azo dye	
EXPERIMENT-4: Determination of surface tension of liquids.	
EXPERIMENT-5: Determination of viscosity coefficients of liquids.	
EXPERIMENT-6: Quantitative Analysis through titrations (Physical and Volumetric) Preparation of standard solution of oxalic acid and standardization of (a) NaOH solution and (b) $KMnO_4$ solution. Estimation of Carbonate and bicarbonate present together in a mixture Estimation of acetic acid in commercial Vinegar. Preparation and standardization Mohr's solution by standard $KMnO_4$ solution. Complexometric titrations**:** Zn^{2+}, Mg^{2+}, Ca^{2+}, Fe^{2+} with EDTA Estimation of total hardness of water by titration with EDTA Estimation of Fe(II) and Fe(III) in a given mixture using standard $K_2Cr_2O_7$	

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3		2			2		2		2	3	2	2		2
CO-2	3		2		2					2	3	2	3		2
CO-3	3	3	3	3	3					2	3	3	3	3	3
CO-4	3		2		2						3	3	3	2	2
CO-5	3		2		2						3	3	3	2	3
CO-6	3	3	3		3						3	3	3	3	3

Microbial genetics (TIU-UBT-MJ-T21201)

Program: B.Sc. Biotechnology	**Year, Semester:** 2^{ND} year., 3^{rd} Sem.
Course Title: Microbial genetics	**Subject Code**: TIU-UBT-MJ-T21201
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective

To introduce students to the fundamental concepts of microbial genetics, including genetic material, DNA structure, replication, plasmids, episomes, and microbial mutants.
To develop an understanding of gene transfer mechanisms in bacteria such as transformation, transduction, and conjugation, and to explore their evolutionary significance and role in antibiotic resistance.
To equip students with knowledge of molecular mechanisms of mutation, DNA repair systems, and modern genetic tools like restriction enzymes and plasmid-based techniques used in microbial genetCourse Outcomes (COs)

Course Outcome

CO No.	Course Outcome	Bloom's Level
CO1	Understand the basic principles and processes of microbial genetics, including plasmids, gene transfer mechanisms, and bacteriophages.	K1
CO2	Describe and explain different types of mutations and their genetic implications in microorganisms.	K2
CO3	Apply the knowledge of genetic elements and molecular techniques such as restriction enzymes, plasmids, and bacteriophages in microbial studies.	K3
CO4	Analyze microbial genetic experiments and interpret results to understand microbial variation and inheritance.	K4
CO5	Evaluate DNA damage and repair mechanisms, and assess tools like the Ames test for mutagenicity and carcinogenic potential.	K4
CO6	Illustrate DNA repair systems and demonstrate understanding through diagrams and models.	K3

Course content

Module	**Topics Covered**
Module I	**15 HOURS**
	Fundamentals of Microbial Genetics - Definition and scope of microbial genetics - Structure and replication of bacterial DNA - Plasmids: types and functions - Episomes - Auxotrophic and other microbial mutants
Module II	**15 HOURS**
	Gene Transfer Mechanisms in Bacteria - Horizontal gene transfer: definition and significance

	- Transformation - Transduction (generalized and specialized) - Conjugation - Role in microbial evolution and antibiotic resistance - Bacteriophages: structure, lytic and lysogenic cycles
Module III	**15 HOURS**
	Mutations and DNA Repair Mechanisms - Types of mutations: point mutations, frame-shift mutations, etc. - Effects of mutations in microbes - Ames test for mutagenicity - DNA damage and repair mechanisms - Specific DNA repair systems (e.g., excision repair, photoreactivation)
Module IV	**15 HOURS**
	Molecular Tools in Microbial Genetics - Restriction endonucleases: types and mechanisms - Role of restriction enzymes in gene manipulation - Rolling circle replication - Application of plasmids and bacteriophages in molecular genetics
Total	**60hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	3		2		2						2	2	2	2	2
CO-2	3		2		2						2	2	2	2	2
CO-3	3	3	3	3	3					2	3	3	3	3	3
CO-4	3	3	3	3	3					2	3	3	3	3	3
CO-5	3	3	3	3	3					3	3	3	3	3	3
CO-6	3	2	2	2	2					2	2	2	3	2	2

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 3RD Sem.
Course Title: Bioprocess Technology	**Subject Code:**TIU-UBT-MI-T21201
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit: 4**

Course Objective:

1. To introduce students to the fundamental principles of bioprocess technology, including fermentation types, microbial growth kinetics, and stoichiometry of cell growth.
2. To familiarize students with bioreactor design, operation, and process optimization, including key engineering parameters affecting microbial and cell culture systems.
3. To provide an understanding of sterilization methods and downstream processing techniques such as filtration, chromatography, and product formulation in bioprocessing.

COURSE OUTCOME

CO No.	Course Outcome	
CO1	Understand the fundamental concepts of bioprocess technology, including fermentation processes and microbial growth kinetics.	K1
CO2	Explain the design, classification, and operational parameters of different bioreactors used in bioprocess industries.	K2
CO3	Apply knowledge of sterilization techniques and microbial death kinetics to optimize bioprocessing conditions.	K3
CO4	Analyze the principles of upstream processing, including fermentation modes and their impact on microbial growth.	K4
CO5	Evaluate different downstream processing techniques such as filtration, centrifugation, chromatography, and product formulation.	K4
CO6	Demonstrate the ability to integrate bioprocess knowledge in designing sustainable and efficient biotechnological production systems.	K3

COURSE CONTENT :

MODULE 1:		**15 Hours**
Basics of Bioprocess technology, Range of fermentation processes, Introduction to Upstream and downstream technology, Modes of fermentation: batch, fed-batch and continuous, Microbial growth kinetics- Monod kinetics, Solid state and submerged fermentation, Stoichiometry of cell growth- Respiratory Quotient, Degree of Reduction		
MODULE 2:		**15 Hours**
Bioreactor design and operation: Bioreactor parts and function, classification of reactors; designing parameters for reactors (stirred tank reactor, airlift reactor, plug flow reactor),		

rheology of fermentation broth, gas-liquid mass transfer, analysis of dimension less parameters and their application (aeration number, power number and Reynold's number;		
MODULE 3:		**10 Hours**
Sterilization- steam and filter sterilization, Batch and continuous sterilization, microbial death kinetics, Microbial, animal and plant cell culture platforms.		
Module 4		**20 hours**
Downstream processing- Cell disruption techniques, Filtration-Cross flow and dead end, ,centrifugation, membrane separation processes, precipitation, chromatography, product formulation and finishing techniques- drying and crystallizatio		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	**3**	**2**	**2**		**2**						**2**	**2**	**3**	**2**	**2**
CO-2	**3**	**2**	**2**	**2**	**2**						**2**	**2**	**3**	**2**	**3**
CO-3	**3**	**3**	**3**	**3**	**3**				**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO-4	**3**	**3**	**3**	**3**	**3**				**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO-5	**3**	**3**	**3**	**3**	**3**				**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO-6	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Library and Information Science (TIU-ULIB-MD-T2101**)**

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 3RD Sem.
Course Title:Library and Information Science	**Subject Code:** TIU-ULIB-MD-T2101
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

Course Objective:

1. To introduce students to the foundational concepts of library science, including the types, roles, and functions of various libraries such as academic, public, national, and special libraries, with a focus on their historical and social importance.
2. To equip students with knowledge and skills related to digital libraries, library automation, classification and cataloguing systems, and the use of ICT and software in modern library management.

3. To develop students' understanding of different information sources and services, including reference tools, databases, digital repositories, and information organization systems to support academic and research activities.

Course Outcomes (COs)

CO Code	Course Outcome	Bloom's Level
CO1	**Identify different types of libraries, their characteristics, and understand their roles in academic and societal development.**	**K1**
CO2	**Explain the organizational structure, functions, and services of academic, public, and national libraries, including major library acts and foundations.**	**K2**
CO3	**Apply the basic principles of library classification, cataloguing, and indexing to organize and retrieve information.**	**K3**
CO4	**Analyze the changing role of libraries in the digital era, and compare digital resources, repositories, and library consortia.**	**K4**
CO5	**Demonstrate understanding of library automation, integrated library systems, and the use of ICT tools and software like Koha, SOUL, and OPAC.**	**K3**
CO6	**Evaluate different information sources including reference tools, databases (e.g., Scopus, Web of Science), and their significance in academic research.**	**K4**

COURSE CONTENT :

MODULE 1:		**10 Hours**
Library, Types, Academic Libraries (School, College, University Libraries), Role of Academic Libraries. Special Library, Types, Role of Special Libraries. Public Library, Missions of Public Libraries, Characteristics, Role in Social Development, Public Library Structure in India, Public Library Act, Public Library Fund, State Central Library, Kolkata. Raja Rammohan Roy Library Foundation. National Library, Characteristics, National Library of India, History, Librarians, Functions, Books acquisition, Services, Collection, Press and Registration of Books Act, The Delivery of Books and Newspaper Act. Some Important National and International Libraries.		
MODULE 3:		**8 Hours**
Main Components of a Library. Five Laws of Library Science. Dr. S. R. Ranganathan.		

Library Departments (Acquisition Department, Technical Departments, Circulation, Reading Room, Digital Section, Reference Section, Rare Collection, Binding and Preservation.) Book Selection Procedure, Library Committee, Library Rules. Accession Register, Secret Page, Stock Verification, Weeding Out, Shelf List, Library Stack, Stack Access, Authority File.

Module 4		**10 hours**
Classification, Library Classification, Classification Language, Classification Scheme, DDC, UDC, CC. Cataloguing, Purpose, 8 Areas of Cataloguing, Catalogue Code, Examples, AACR, RDA, ISBD, FRBR. Union Catalogue, Interlibrary Loan, ISBN, ISSN. Indexing, Indexing Language, Chain Indexing, POPSI, PRECIS. ICT, Key Applications of ICT in Libraries, Benefits of ICT in Libraries. Integrated Library System. Library Automation, Library Management Software, Examples- Koha, LibSys, Evergreen, Granthalaya, Soul, Choosing a Library Management System, OPAC, Importance of OPAC. Software, Binary Code, Source Code, Open-Source Software, Freeware, Commercial Software, Difference. Library Services, Library OPAC, Reference Service, Currents Awareness Service (CAS		

Module 5	**7 hours**
Data, Information, Knowledge, Wisdom. Information Sources, Types. Documentary sources (Primary, Secondary, Tertiary), Non-Documentary Sources, Reference Sources, Electronic Sources, Selecting Information Sources. Encyclopaedias, Dictionaries, Directories, Biographical Sources, thesaurus, Bibliographies, Yearbooks. Printed and Digital Reference Sources. Database. Cloud Database, Types, Advantages, Example. Scopus, Key Features, Use. Web Of Science, Key Features, Use, Key Databases within WOS, Advantages. Bigdata, Characteristics, Applications, Challenges.	

TOTAL LECTURES	**45Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**1**	**1**	**1**	**2**	**3**

										0	**1**	**2**			
CO-1	**3**	**2**	**2**			**2**	**3**			**2**	**2**	**2**			
CO-2	**3**	**2**	**3**	**2**			**2**	**2**		**3**	**2**	**2**			
CO-3	**3**	**3**	**3**	**2**				**2**	**2**	**2**	**3**	**2**	**2**		
CO-4	**3**	**3**	**3**	**3**	**2**			**3**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**3**	**3**	**3**	**3**	**2**			**3**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-6	**3**	**3**	**3**	**2**	**3**			**3**		**2**	**3**	**3**	**2**	**3**	**2**

MODERN INDIAN LANGUAGE – HINDI (TIU-UEN-AEC-S2191A**)**

Program: BSc in Biotech	**Year, Semester: 2ND Year, 3rd Sem**
Course Title: Heritage of Modern Indian Languages-I	**Subject Code:**TIU-UEN-AEC-T2101
Contact Hours/Week: 2-0-0 (L-T-P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. To develop foundational knowledge of Hindi grammar and vocabulary, enabling students to construct simple sentences and engage in basic reading and writing tasks.
2. To enhance listening and speaking skills through interactive classroom activities, dialogues, and pronunciation practice, focusing on everyday conversational Hindi.
3. To introduce students to literary appreciation through two short stories and one poem in Hindi, fostering comprehension, discussion, and cultural understanding

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recognize and reproduce the Devanagari script accurately while reading and writing basic Hindi words and sentences.	K1
CO-2:	Apply basic Hindi grammar rules and vocabulary to construct simple, grammatically correct sentences.	K3
CO-3:	Demonstrate the ability to engage in short conversations using appropriate expressions, pronunciation, and sentence structures	K3
CO-4:	Interpret and explain the central ideas and themes of two selected short stories and one poem in Hindi.	K2
CO-5:	Analyze the use of language and cultural elements present in the literary texts to deepen appreciation of Hindi literature.	K4
CO-6:	Improve comprehension by responding to questions based on audio inputs and classroom discussions in Hindi.	K2

COURSE CONTENT :

MODULE 1:	मंत्र (कहानी): मुंशीप्रेमचंद	**5 Hours**
इसकहानीकेमाध्यमसेविद्यार्थीमेंमानवतावादीमूल्योंका विकासहोपाएगा।वेपरोपकार , न्याय , सेवाऔरकर्तव्यकीभावनाकोग्रहणकरपाएंगे।		
MODULE 2:	त्रिशंकु (कहानी) :मन्नूभण्डारी	**5 Hours**
इसकहानीकेमाध्यमसेविद्यार्थीअपनेपुरानीपीढ़ीअर्थात्अ पनेबड़ोंकाआदरकरनासीखपाएंगे।उनमेंनैतिकमूल्योंकाविका सहोसकेगा।नईऔरपुरानीपीढ़ीकेमध्यअंतरकोभीसमझानेकाप्रय ासकियाजाएगा।		
MODULE 3:	उनकोप्रणाम (कविता) :नागार्जुन	**5 Hours**
इसकविताकेमाध्यमसेविद्यार्थीअपनेकर्तव्यऔरदायित्वके प्रतिजिम्मेदारबनपाएंगे।उनमेंअपनेपरिवार , समाज , देशऔरविश्वकेप्रतिअपनेकर्तव्यबोधकाएहसासहोसकेगा।		
MODULE 4:	भिक्षुक (कविता) :सूर्यकांतत्रिपाठीनिराला	**5 Hours**
इसकविताकेमाध्यमसेविद्यार्थीबेबसऔरलाचारव्यक्तियोंक ेप्रतिदयाभावरखपाएंगे।उनमेंसमाजकेसर्वहारावर्गकेप्र तिप्रेम , सेवाऔरअपनेपनकीभावनाकाविकासहोसकेगा।		
MODULE 5:	पारिभाषिकशब्दावली	**5 Hours**
इसकेमाध्यमसेविद्यार्थीहिन्दीभाषाकेराजभाषास्वरूपका अध्ययनकरपाएंगे।वेहिन्दीकेराजभाषाशब्दावलियोंकाकार् यालयीक्षेत्रमेंप्रयोगकरपाएंगे।		
MODULE 6:	समूहचर्चा	**5 Hours**
इसकेमाध्यमसेविद्यार्थियोंमेंहिन्दीभाषामेंकौशलप्रा प्तहोसकेगा।वेअपनीभावनाओंकोअच्छीतरहहिन्दीभाषामेंप् रकटकरसकेंगे।		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	**3**	**1**	**2**	**1**	**0**	**0**	**2**	**2**	**1**	**2**	**2**	**2**	**0**	**0**	**0**
CO-2	**3**	**2**	**3**	**2**	**1**	**0**	**2**	**3**	**2**	**2**	**2**	**3**	**0**	**0**	**0**

CO-3	**3**	**2**	**3**	**2**	**1**	**0**	**2**	**3**	**3**	**2**	**2**	**3**	**0**	**0**	**0**
CO-4	**2**	**1**	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**3**	**2**	**2**	**0**	**1**	**0**
CO-5	**2**	**2**	**3**	**3**	**2**	**1**	**3**	**3**	**2**	**3**	**2**	**3**	**0**	**2**	**0**
CO-6	**2**	**1**	**3**	**2**	**1**	**0**	**2**	**3**	**2**	**2**	**2**	**3**	**0**	**1**	**0**

MODERN INDIAN LANGUAGE- BENGALI (TIU-UEN-AEC-S2191B)

Program: BSc in Biotech	Year, semester: 2nd yr, 3rd semester
Course Title: MODERN INDIAN LANGUAGE- BENGALI	**Subject Code:** TIU-UEN-AEC-S2191B
Contact Hours/Week: 2-0-0 (L-T-P)	**Credit: 0**2

COURSE OBJECTIVE :

Enable the student to:

Develop Bengali proficiency for clear, precise, and confident workplace communication.

Enhance practical skills in vocabulary, grammar, pronunciation, speaking, and writing.

Apply communication theories to improve professional and interpersonal interactions.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Explain fundamental communication principles and their relevance in workplace interactions.	K2
CO-2:	Apply grammar and language skills to construct precise and coherent spoken and written communication.	K3
CO-3:	Demonstrate fluency in spoken Bengali through pronunciation drills, vocabulary building, and interactive conversations.	K4
CO-4:	Construct well-organized sentences, paragraphs, and linked paragraphs to enhance professional writing	K3
CO-5:	Develop and revise written communication by employing strategies for drafting, editing, and proofreading.	K3
CO-6:	Assess and refine communication skills to ensure clarity, precision, and confidence in workplace interactions.	K4

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO COMMUNICATION**	**10Hours**
এইকোর্সটিপড়ারপরশিক্ষার্থীদেরবাংলাভাষাওসাহিত্যসম্পর্কেসম্যকধারণাতৈরিহবে। পঠনবোধগম্যতারমধ্যেদিয়েকিছুমৌলিকদক্ষতাঅর্জনকরবে। শব্দেরঅর্থজানা, বিষয়বস্তুসম্পর্কেসিদ্ধান্তেপৌঁছানএবংশব্দভাণ্ডারউন্নতকরা। এছাড়াসঠিকভাবেলেখারদক্ষতাঅ		

র্জনকরবে।		
MODULE 2:	**LANGUAGE AND GRAMMAR SKILLS**	**10 Hours**
এইকোর্সটিসম্পূর্ণহওয়ারপরশিক্ষার্থীরাবাংলাবানানেরসঠিকউচ্চারণএবংবানানসম্পর্কিতনানাত থ্যেরঅনুসন্ধানকরবে। অনুবাদেরবিশেষদক্ষতাবাকৌশলকেআয়ত্তকরবে। এছাড়াওবিভিন্নপ্রকা রেরআবেদনপত্রলেখারনিয়ম-নীতিজানবেএছাড়াপরিভাষারসঙ্গেপরিচিতিলাভকরবে।		
MODULE 3:	**SPEAKING SKILLS**	**10 Hours**
এইকোর্সটিশিক্ষার্থীদেরবাংলাভাষাওসাহিত্যসম্পর্কেযেবিশেষধারণাতৈরিতেসাহায্যকরবেতারফলে শিক্ষার্থীরানিজেদেরমতনকরেভাষাপ্রয়োগেরকৌশলআয়ত্তকরবেএছাড়াবিভিন্নধরনেরপাঠদানে অংশগ্রহণকরারসুযোগলাভকরবে।		
TOTAL LECTURES		**30 Hours**

Molecular Diagnostics (TIU-UBT-SEC-T2101)

Program: B. SC. in Biotech	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Molecular Diagnostics	**Subject Code:**TIU-UBT-SEC-T2101
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:

1. Understand the role of biotechnology in healthcare and disease diagnosis.
2. Learn biochemical and molecular diagnostic techniques for disease detection.
3. Explore molecular therapy approaches, including gene therapy and enzyme therapy.
4. Analyze emerging trends in diagnostics and personalized medicine**.**

COURSE OUTCOME (COs):

CO No.	**Course Outcome Statement**	
CO1	Define fundamental concepts of medical biotechnology, including human physiology, disease types, and their causes.	KI
CO2	Explain the principles and applications of biochemical and molecular diagnostic techniques such as PCR, ELISA, and HPLC.	K2
CO3	Illustrate the role of biochemical markers in disease diagnosis, including liver function tests, kidney function tests, and hormonal assays.	K2
CO4	Apply knowledge of molecular diagnostics in prenatal screening using invasive and non-invasive techniques.	K3
CO5	Demonstrate the application of molecular therapy approaches such as gene therapy, RNA-based therapeutics, and monoclonal antibody therapy in treating	K3

	diseases.	
CO6	Analyze the significance of regenerative medicine and stem cell therapy in modern healthcare and disease treatment.	K4

COURSE CONTENT:

MODULE 1:	**Introduction to Medical Biotechnology**	**15 Hours**
An introduction to medical biotechnology: Biotechnology and health care; Basic human physiology; Definition of disease and its types: Genetic disease, Metabolic disease, Immune system malfunction and disease, Hormonal disease, Vitamin and minerals deficiency diseases.		
MODULE 2:	**Biochemical and Molecular Diagnostics**	**15 Hours**
Biochemical and Molecular Diagnostics: Different biochemical test using protein and enzyme markers and their interpretation. e.g. Liver function test, kidney function test, blood sugar test, hormone assay etc. Molecular diagnostics: PCR based detection, Microarray, Protein profiling by HPLC, FACS, ELISA. Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive techniques -Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood.		
MODULE 3:	**Molecular Therapy & Regenerative Medicine**	**15 Hours**
Molecular therapy: Gene therapy: DNA based vaccine, RNA based therapeutics, Antisence therapeutics; Enzyme therapy; Hormone therapy; Cytokine therapy; Monoclonal Antibody therapy. An introduction to stem cell therapy and regenerative medicine.		
TOTAL LECTURES		**45 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**3**	**2**	**1**	**2**
CO-2	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**3**
CO-3	**3**	**2**	**3**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**3**
CO-4	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CO-5	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
CO-6	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**

Cytogenetics Lab (TIU-UBT-MJ-L21201)

Program: B. Sc. in Biotech	**Year, Semester: 2nd**Yr., 3rd Sem.

Course Title: Cytogenetics Lab	**Subject Code:** TIU-UBT-MJ-L21201
Contact Hours/Week:0 –0–4 (L–T-P)	**Credit: 2**

Course objective

1. To provide hands-on training in cytological techniques such as mitotic and meiotic slide preparation, chromosomal staining, and mitotic index calculation for studying cell division.
2. To develop the ability to identify, analyze, and interpret chromosome structures, karyotypes, Barr bodies, and chromosomal aberrations using microscopy and image-based tools.
3. To introduce students to cytogenetic applications in medical genetics through case-based learning on chromosomal disorders and virtual observation of specialized chromosomes like polytene chromosomes.

Course outcome:

CO No.	**Course Outcome**	
CO1	Recall and describe the stages of mitosis and meiosis through root tip and flower bud cell analysis.	**K1**
CO2	Understand the principles and techniques of chromosomal staining using Giemsa and Acetocarmine.	**K2**
CO3	Prepare and analyze human/mouse karyotypes and identify sex chromatin (Barr bodies) in buccal smears.	**K3**
CO4	Identify chromosomal aberrations using prepared slides/images and correlate them with cytogenetic abnormalities.	**K3**
CO5	Calculate the mitotic index and interpret the biological significance of active cell division.	**K4**
CO6	Evaluate chromosomal disorders (e.g., Down syndrome, Turner syndrome) through case studies and virtual observation of polytene chromosomes.	**K4**

Course content

Practical Title	Total-60 hours
Study of mitosis in root tip cells (onion/Allium cepa)	
Study of meiosis in flower bud (grasshopper/testis/anther)	
Preparation of karyotype (human/mouse) from photographs	
Chromosome staining techniques (Giemsa, Acetocarmine)	
Study of Barr bodies in human cheek cells	
Identification of chromosomal aberrations using prepared slides/images	
Study of sex chromatin in buccal smear	
Preparation of temporary slides for mitotic index calculation	
Observation of polytene chromosomes (Drosophila larval salivary glands) – demo or virtual	
Case study/discussion on cytogenetic disorders (e.g., Down syndrome, Turner syndrome)	

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	2	2	1	1	1	1	1	1	2	2	2	2	1	2
CO-2	3	2	2	2	2	1	1	1	1	2	2	2	3	2	3
CO-3	3	2	3	2	2	1	1	2	2	2	2	2	3	2	3
CO-4	3	3	3	2	2	1	1	2	2	2	2	2	3	2	3
CO-5	3	3	3	2	2	1	1	2	2	2	2	2	3	2	3
CO-6	3	3	3	3	3	1	1	2	2	3	2	2	3	3	3

Bioprocess Technology Lab (TIU-UBT-MI-L21201)

Program: B. Sc. in Biotech	**Year, Semester: 2nd**Yr., 3rd Sem.
Course Title: Bioprocess Technology Lab	**Subject Code:** TIU-UBT-MI-L21201
Contact Hours/Week:0 –0–4 (L–T-P)	**Credit: 2**

COURSE OBJECTIVE :

Enable the student to:

1. Understand Microbial Growth and Survival – Introduce students to bacterial growth dynamics and factors influencing microbial survival, including thermal death point (TDP) determination.
2. Develop Skills in Bioproduct Synthesis and Analysis – Train students in the production and characterization of industrially important bioproducts such as ethanol, amylase, and lactic acid.
3. Apply Bioprocess Techniques for Industrial Applications – Equip students with the ability to isolate and analyze microorganisms from natural sources for their potential use in biotechnological industries.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Identify the key principles of bacterial growth and understand its significance in microbial studies.	K1
CO-2:	Describe the concept of thermal death point (TDP) and its importance in microbial regulation and control.	K2
CO-3:	Carry out the production of ethanol and examine its properties using	K3

	biochemical assessment techniques.	
CO-4:	Execute the extraction and characterization of amylase, demonstrating its enzymatic efficiency and activity.	K3
CO-5:	nvestigate the process of lactic acid production through microbial fermentation and evaluate its biochemical properties.	K4
CO-6:	Extract and study microorganisms from natural sources, assessing their industrial relevance and applications.	K4

COURSE CONTENT:

Experiment	**Total (60 hours)**
Bacterial growth curve	
Calculation of thermal death point (TDP) of a microbial sample.	
Production and analysis of ethanol.	
Production and analysis of amylase.	
Production and analysis of lactic acid.	
Isolation of industrially important microorganism from natural resource.	

Course Articulation Matrix

	PROGRAME OUTCOME (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**
CO2	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**1**	**2**
CO3	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Molecular Biology (TIU-UBT-MJ-T22201**)**

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title:Molecular Biology	**Subject Code:**TIU-UBT-MJ-T22201
Contact Hours/Week:3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1. To introduce the fundamental principles of molecular biology, including DNA structure, replication mechanisms, and chromosomal organization in prokaryotes and eukaryotes.
2. To explain the processes of transcription, RNA processing, translation, and gene regulation, emphasizing their role in cellular function and genetic expression.
3. To develop an understanding of DNA damage, repair mechanisms, homologous recombination, and their implications in maintaining genomic stability.

COURSE OUTCOME :

CO No.	Course Outcome	
CO1	Explain the structure, types, and functions of DNA, and describe the mechanisms of DNA replication in prokaryotes and eukaryotes.	K2
CO2	Analyze different types of DNA damage and explain the various DNA repair mechanisms, including homologous recombination.	K4
CO3	Describe the processes of transcription and RNA processing in prokaryotes and eukaryotes, including key enzymes and regulatory elements.	K2
CO4	Compare and contrast gene regulation mechanisms in prokaryotes and eukaryotes, focusing on operons, promoters, and transcription factors.	K3
CO5	Illustrate the molecular mechanisms of translation, including ribosome assembly, tRNA charging, and polypeptide synthesis.	K3
CO6	Evaluate the significance of post-translational modifications and the impact of translation inhibitors on protein synthesis.	K4

COURSE CONTENT :

MODULE 1:		**15 Hours**
DNA structure and replication DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotesand eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNApolymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rollingcircle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.		
MODULE 2:		**15 Hours**
DNA damage, repair and homologous recombination DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair:Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesionsynthesis, recombinational repair, nonhomologous end joining. Homologous recombination:models and mechanism.		
MODULE		**15 Hours**

3:		
Transcription and RNA processing 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 RNAsplicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing,rRNA and tRNA splicing.		
MODULE 4:		**15 hours**
Regulation of gene expression and translation Regulation of gene expression in prokaryotes: Operon concept (inducible and repressiblesystem), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosomestructure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism ofinitiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors oftranslation.,Posttranslational modifications of proteins.		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	1	2	1	1	1	1	1	2	2	3	2	2
CO 2	3	3	3	2	3	1	1	1	1	2	3	3	3	3	3
CO 3	3	2	2	1	2	1	1	2	1	1	2	2	3	2	2
CO 4	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 5	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 6	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3

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Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title: Parasitology and Immunology	**Subject Code:** TIU-UBT-MJ-T22202
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1. Understand the fundamental concepts of the immune system, including its components, immune responses, and molecular structure of immunoglobulins, along with T-cell and B-cell receptor mechanisms.
2. Analyze the genetic and molecular basis of antibody diversity, immunoglobulin gene regulation, clonal selection, and immune memory, and explore the mechanisms behind immune system regulation.
3. Evaluate the role of immunological mechanisms in health and disease, including antigen processing, immune responses to pathogens, autoimmune diseases, immunodeficiency disorders, and advancements in vaccine development and immunodiagnostics.

COURSE OUTCOME :

CO No.	Course Outcome Statement	
CO1	Understand the fundamental principles of immunology by identifying key components of the immune system, including immune cells, immunoglobulins, and T-cell responses.	K1
CO2	Explain the molecular mechanisms of immune responses, including antibody generation, class switching, and genome rearrangements during B and T cell differentiation.	K2
CO3	Analyze the genetic basis of immunoglobulin gene expression and antibody diversity, including clonal selection theory, allelic exclusion, and mechanisms of immunologic memory.	K3
CO4	Evaluate the role of major histocompatibility complexes (MHC) and antigen processing mechanisms in immune system regulation and pathogen defense.	K3
CO5	Assess immune-related disorders such as autoimmune diseases and immunodeficiencies (e.g., AIDS), exploring their underlying mechanisms and clinical significance.	K4
CO6	Demonstrate knowledge of immunization strategies and immunodiagnostic	K4

	techniques, including vaccine development, ELISA, and RIA, in disease prevention and diagnostics.	

COURSE CONTENT :

MODULE 1:		**15 Hours**
UNIT I		**(20 Periods)**
Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.		
MODULE 2:		**15 Hours**
UNIT II		**(15 Periods)**
Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.		
MODULE 3:		**15 Hours**
UNIT III		**(13 Periods)**
Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.		
Module 4		**15 hours**
UNIT IV		**(12 Periods)**
Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOME (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	1	2	1	1	1	1	1	2	2	3	2	2
CO 2	3	3	2	1	2	1	1	2	1	2	2	2	3	2	2
CO 3	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3

CO 4	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 5	3	3	3	2	3	2	2	2	2	2	3	3	3	3	3
CO 6	3	3	3	2	3	2	2	2	2	2	3	3	3	3	3

INSTRUMENTATION AND TECHNIQUE – II (TIU-UBT-MI-T22201**)**

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title:INSTRUMENTATION AND TECHNIQUE – II	**Subject Code:** TIU-UBT-MI-T22201
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

Course Objective:

1. To introduce the fundamental principles and applications of spectroscopy, chromatography, electrophoresis, centrifugation, and microscopy techniques in biotechnology.
2. To equip students with knowledge of modern analytical techniques used for biomolecular identification, purification, and structural analysis.
3. To develop practical skills in using advanced biotechnological instruments for qualitative and quantitative analysis in laboratory research and industrial applications.

COURSE OUTCOME :

CO No.	Course Outcome Statement	
CO1	Explain the fundamental principles of spectroscopy, including UV-Visible, Fluorescence, IR, and Atomic Absorption Spectroscopy, and their applications in biomolecular analysis.	K 1
CO2	Describe and compare various chromatographic techniques such as Paper Chromatography, TLC, HPLC, GC, Gel Filtration, and Affinity Chromatography for biomolecule separation and purification.	K 2
CO3	Demonstrate the principles and applications of electrophoresis techniques, including agarose gel, polyacrylamide gel, and isoelectric focusing, in the separation of nucleic acids and proteins.	K 3
CO4	Apply centrifugation techniques such as ultracentrifugation, differential, and density gradient centrifugation for the fractionation of cellular components.	K 3
CO5	Analyze the working principles and applications of Mass Spectrometry (MS), X-	K

	ray Crystallography, and NMR Spectroscopy in biomolecular identification and structure determination.	4
CO6	Evaluate the role of advanced microscopy techniques, including light, fluorescence, and electron microscopy (TEM, SEM), in cellular imaging and structural analysis.	K 4

COURSE CONTENT :

MODULE 1:		**12 Hours**
Basic Principles of Spectroscopy: Introduction to the interaction between light and matter, absorption, emission, and scattering of light.UV-Visible Spectroscopy: Principles, instrumentation, and applications in quantitative analysis of biomolecules. Fluorescence Spectroscopy: Theory, instrumentation, and applications in protein and nucleic acid studies. Infrared (IR) Spectroscopy: Principles of IR absorption, functional group analysis, and applications in biomolecular identification. Atomic Absorption Spectroscopy (AAS): Principle, instrumentation, and applications in detecting trace elements in biological samples		
MODULE 2:		**12 Hours**
Basic Principles of Chromatography: Partition, adsorption, and ion-exchange chromatography. Paper and Thin Layer Chromatography (TLC): Techniques, mechanisms, and applications in separation of biomolecules. High-Performance Liquid Chromatography (HPLC): Principle, instrumentation, and applications in protein and drug analysis. Gas Chromatography (GC): Fundamentals, instrumentation, and applications in volatile compound analysis. Gel Filtration and Affinity Chromatography: Techniques for protein purification and molecular size determination.		
MODULE 3:		**10 Hours**
Gel Electrophoresis: Principles of agarose and polyacrylamide gel electrophoresis for nucleic acids and proteins. Isoelectric Focusing and 2D Gel Electrophoresis: Techniques for protein separation based on isoelectric point and molecular weight. Centrifugation: Principles and applications of preparative and analytical centrifugation. Ultracentrifugation, differential, and density gradient centrifugation for subcellular fractionation		
Module 4		**11 hours**
Mass Spectrometry (MS): Basic principles, instrumentation, and applications in protein and metabolite identification. X-ray Crystallography: Fundamentals, instrumentation, and applications in determining 3D structures of biomolecules. Nuclear Magnetic Resonance (NMR) Spectroscopy: Principles, instrumentation, and applications in studying biomolecular structure and dynamics. Microscopy Techniques: Light microscopy, fluorescence microscopy, and electron microscopy (TEM, SEM) in cellular imaging and analysis.		
TOTAL LECTURES		**45 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOME (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	2	1	1	2	1	1	2	2	3	2	2
CO2	3	3	2	1	2	1	1	2	1	2	2	2	3	2	3
CO3	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO4	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO5	3	3	3	2	3	2	1	2	2	2	3	3	3	3	3
CO6	3	3	3	2	3	2	1	2	2	2	3	3	3	3	3

MODERN INDIAN LANGUAGE – HINDI (TIU-UEN-AEC-S2291A)

Program: BSc in Biotechnology	**Year, Semester: 2ND Year, 4th Sem**
Course Title: MODERN INDIAN LANGUAGE – HINDI	**Subject Code:** TIU-UEN-AEC-S2291A
Contact Hours/Week: 2-0-0 (L-T-P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Strengthen students' command of Hindi grammar, vocabulary, and sentence construction through advanced reading, writing, and conversation practice.

2. Develop literary appreciation by engaging with selected short stories and poems, with a focus on understanding themes, characters, and cultural context.

3. Encourage confident expression in spoken and written Hindi through class discussions, role-plays, narrations, and short compositions on everyday and cultural topics.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall and use extended Hindi vocabulary and idiomatic expressions in both oral and written communication.	K1
CO-2:	Construct coherent and grammatically accurate short paragraphs and	K3

	dialogues on familiar topics.	
CO-3:	Interpret themes, messages, and character motivations from selected Hindi short stories and poems.	K2
CO-4:	Compare and contrast cultural values, traditions, and social issues as portrayed in Hindi literary texts.	K4
CO-5:	Deliver short oral presentations or narrations in Hindi on everyday and cultural topics with improved fluency.	K3
CO-6:	Evaluate the literary and linguistic qualities of Hindi texts through class discussions, assignments, or presentations.	K5

COURSE CONTENT

MODULE 1:	घीसा (कहानी): महादेवीवर्मा	**5 Hours**
इसकहानीकेमाध्यमसेविद्यार्थीमेंमानवतावादीमूल्योंका विकासहोपाएगा।वेपरोपकार , न्याय , सेवाऔरकर्तव्यकीभावनाकोग्रहणकरपाएंगे।		
MODULE 2:	कौनसीजमीनअपनी (कहानी) :सुधाओमढींगरा	**5 Hours**
इसकहानीकेमाध्यमसेविद्यार्थीसंयुक्तपरिवारकेमहत्वको समझपाएंगे।उनमेंअपनीमातृभूमिकेप्रतिप्रेमऔरलगावकीभा वनाकासंचारहोपाएगा।		
MODULE 3:	होगईहैपीरपर्वतसी (कविता) :दुष्यंतकुमार	**5 Hours**
इसकविताकेमाध्यमसेविद्यार्थीअपनेकर्तव्यऔरदायित्वके प्रतिजिम्मेदारबनपाएंगे।उनमें अपनेपरिवार , समाज , देशऔरविश्वकेप्रतिअपनेकर्तव्यबोधकाएहसासहोसकेगा।		
MODULE 4:	धार्मिकदंगोंकीराजनीति (कविता) :शमशेरबहादुरसिंह	**5 Hours**
इसकविताकेमाध्यमसेविद्यार्थीधर्मकेसहीअर्थकोसमझपाएं गे।वेदेशकीविवधतामेंएकताकीभावनाकोसमझपाएंगे।		
MODULE 5:	अनुवाद (अंग्रेजीसेहिन्दी)	**5 Hours**
इसकेमाध्यमसेविद्यार्थीहिन्दीभाषामेंअनुवादकाकौशलप् राप्तकरपाएंगे।वेहिन्दीकेराजभाषाशब्दावलियोंकाकार्य ालयीक्षेत्रमेंप्रयोगकरपाएंगे।		
MODULE 6:	समूहचर्चा	**5 Hours**
इसकेमाध्यमसेविद्यार्थियोंमेंहिन्दीभाषामेंकौशलप्रा प्तहोसकेगा।वेअपनीभावनाओंकोअच्छीतरहहिन्दीभाषामेंप् रकटकरसकेंगे।		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOME (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	**2**	**1**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**2**	**3**	**0**	**0**	**0**
CO 2	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**0**	**0**	**0**
CO 3	**3**	**1**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**0**	**0**	**0**
CO 4	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**0**	**0**	**0**
CO 5	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**0**
CO 6	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**0**	**0**	**0**

MODERN INDIAN LANGUAGE- BENGALI (TIU-UEN-AEC-S2291B)

Program: BSc in Biotechnology	Year, semester: 2nd yr, 4TH semester
Course Title: MODERN INDIAN LANGUAGE- BENGALI	**Subject Code:** TIU-UEN-AEC-S2291B
Contact Hours/Week: 2-0-0 (L-T-P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Enhance understanding of Bengali grammar and vocabulary, enabling them to construct more complex sentences and express ideas clearly in both spoken and written forms.

2. Strengthen listening and speaking skills in Bengali through audio materials, conversations, narrations, and interactive classroom activities.

3. Develop literary appreciation and cultural awareness by engaging with selected literary texts, focusing on themes, narrative techniques, and the use of language in context.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Recall and use an expanded set of Bengali vocabulary and grammar structures in both oral and written communication.	K1
CO-2:	Apply appropriate grammatical rules to frame longer and more coherent sentences and paragraphs in Bengali.	K3
CO-3:	Demonstrate improved listening and speaking proficiency by participating in conversations, role-plays, and oral presentations.	K3
CO-4:	Interpret the themes, characters, and messages of selected Bengali literary texts,	K1
CO-5:	Analyze the use of language, cultural references, and literary elements in the prescribed literary texts.	K4
CO-6:	Express personal views and summaries related to the stories and poem both orally and in writing, showing comprehension and engagement.	K5

COURSE CONTENT:

MODULE 1:	**ব্যাকরণওশব্দভাণ্ডার**	**5 Hours**
• বর্ণওধ্বনিগতরূপান্তর • ক্রিয়াওক্রিয়াররূপান্তর (কাল, পুরুষ, সংখ্যাঅনুযায়ী) • শব্দগঠনওবাক্যগঠন • অনুবাদ: ইংরেজিথেকেবাংলাছোটবাক্যঅনুশীলন		
MODULE 2:	**শ্রবণওকথোপকথন**	**5 Hours**
শ্রুতিবোধ: অডিওক্লিপওছোটবাংলাগল্পশোনাওবোঝা শ্রুতিবোধমূলকপ্রশ্নোত্তরঅনুশীলন দৈনন্দিনকথোপকথন – বাজারে, রাস্তায়, কলেজে ছোটবক্তৃতা/ভাষণঅনুশীলন		
MODULE 3:	**গল্পপাঠ – “ছুটি” ওজনপ্রিয়চরিত্র**	**5 Hours**
“ছুটি” – রবীন্দ্রনাথঠাকুর:মূলভাব, চরিত্রবিশ্লেষণ, সমাজওসংস্কৃতিরপ্রভাব টেনিদা / ঘনাদা / ভোম্বলসরকার (যেকোনোএকটি):		

হাস্যরস, ভাষারব্যবহার, কল্পনারপ্রয়োগ গল্পআলোচনাওছোটরচনালেখা		
MODULE 4:	**কবিতাপাঠ – শক্তিওরবীন্দ্রনাথ**	**5 Hours**
“অবনীবাড়িআছো?” – শক্তিচট্টোপাধ্যায়: আধুনিকতারপ্রেক্ষাপট, ভাষারবহুমাত্রিকতা “প্রশ্ন” – রবীন্দ্রনাথঠাকুর: আধ্যাত্মিকতা, অস্তিত্বওমানবতাবোধ কবিতারছন্দওঅলঙ্কারবিশ্লেষণ		
MODULE 5:	**অভিব্যক্তিওমূল্যায়ন**	**5 Hours**
রচনামূলককার্যকলাপ: নিজেরঅভিজ্ঞতানিয়েলেখা কবিতারভাবসম্প্রসারণ		
MODULE 6:	**শ্রুতিওপাঠভিত্তিকমূল্যায়ন**	**5 Hours**
মৌখিকউপস্থাপনা: গল্প/কবিতাব্যাখ্যাওপ্রতিক্রিয়াপ্রকাশ		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	2	1	2	1	1	1	2	3	2	2	2	3	0	0	0
CO 2	2	2	2	2	1	1	2	3	2	2	3	3	0	0	0
CO 3	2	2	2	2	1	1	2	3	3	2	3	3	0	0	0
CO 4	3	1	3	2	2	2	2	2	1	2	2	3	0	0	0
CO 5	3	2	3	3	2	2	2	3	2	3	3	3	0	0	0
CO 6	2	2	3	3	2	2	2	3	2	3	3	3	0	0	0

Gender studies (TIU-UWS-CVA-T2201)

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title: Gender studies	**Subject Code:TIU-UWS-CVA-T2201**
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit: 2**

Course Objective:

1. Develop a Critical Understanding of Gender in Science and Society

Examine key concepts in gender studies, including sex, gender identity, and social constructions of gender.

Analyze how gender roles, stereotypes, and feminist theories shape education, careers, and scientific progress.

2 Assess the Impact of Gender on Scientific Research and Biotechnology

Investigate the contributions and challenges of women in STEM, gender bias in research, and ethical concerns in biotechnology.

Explore gendered innovations and how inclusive approaches can drive advancements in biotechnology and healthcare.

3 Evaluate Gendered Perspectives in Health, Ethics, and Global Development

Understand the influence of gender on health outcomes, reproductive technologies, and mental health.

Analyze gender policies, sustainable development goals, and the role of biotechnology in addressing global challenges.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Define and explain key gender concepts, including sex, gender identity, gender expression, and feminist theories.	K1
CO2	Understand how gender roles, stereotypes, and norms are shaped by historical, social, and cultural factors, particularly in science and education.	K2
CO3	Analyze gender bias in STEM fields, scientific research, and the impact of gendered innovations in biotechnology.	K3
CO4	Evaluate ethical implications of biotechnological advancements from a gender perspective and explore gender inclusivity strategies in the workplace.	K4
CO5	Investigate the role of gender in healthcare access, reproductive technologies,	K3

	and mental health, considering their societal impact.	
CO6	Critically assess global gender policies, economic opportunities, and sustainable development, focusing on biotechnology-driven solutions.	K4

COURSE CONTENT :

MODULE 1:		**10 Hours**
Key Concepts in Gender Studies: Sex, gender, sexuality, masculinity, femininity, gender identity, and gender expression. Social Construction of Gender: How gender roles and identities are shaped by culture, society, and historical contexts. Gender Stereotypes and Norms: Understanding traditional gender roles, stereotypes in society, and their implications in personal and professional lives. Feminist Theories: Key feminist movements, gender equality, and intersectionality. Gender and Education: The role of gender in education and its influence on career choices, especially in science and technology.		
MODULE 2:		**10 Hours**
Women in Science: Contributions of women scientists, barriers faced, and the underrepresentation of women in STEM fields. Gender Bias in Research: Understanding gender biases in scientific research and how it affects the development of technology, healthcare, and biotechnology. Gendered Innovations: How considering gender can lead to new scientific discoveries and innovations in biotechnology and other fields. Gender and Ethics in Biotechnology: Ethical implications of biotechnological advancements (reproductive technologies, genetic engineering) from a gender perspective. Workplace Dynamics in Science and Technology: Gender roles and leadership in the biotechnology workforce, gender pay gap, and strategies for achieving gender inclusivity		
MODULE 3:		**10 Hours**
Gender and Health: How gender influences health outcomes, access to healthcare, and medical research. Reproductive Rights and Technologies: The role of biotechnology in reproductive health (IVF, contraception, genetic screening) and its gendered implications. Gender and Mental Health: Gender differences in mental health diagnosis, treatment, and societal perceptions. Global Perspectives on Gender Equality: Gender policies and their impact on education, health, and economic opportunities across different cultures. Gender and Sustainable Development: Role of gender in addressing global challenges like poverty, climate change, and food security, with an emphasis on biotechnological solutions.		
TOTAL LECTURES		**30 Hours**

Course Articulation Matrix: (to be generated using campus.technology

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**3**
CO2	**3**	**2**	**3**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

CO4	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**3**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Molecular Biology lab (TIU-UBT-MJ-L22201**)**

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title:Molecular Biology lab	**Subject Code:**TIU-UBT-MJ-L22201
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 2**

Course Objective:

1. Develop Fundamental Laboratory Skills in Molecular Biology
2. Train students in the preparation of essential solutions and reagents required for molecular biology experiments.
3. Ensure accuracy in handling and measuring biochemical solutions for DNA-related procedures.

COURSE OUTCOME :

CO No.	**Course Outcome (COs)**	
CO1	**Prepare and standardize solutions required for molecular biology experiments.**	**K1**
CO2	**Demonstrate the isolation of chromosomal DNA from bacterial cells.**	**K2**
CO3	**Perform plasmid DNA isolation using the alkaline lysis method.**	**K3**
CO4	**Analyze genomic and plasmid DNA using agarose gel electrophoresis.**	**K3**
CO5	**Prepare and execute restriction enzyme digestion of DNA samples.**	**K4**
CO6	**Demonstrate the AMES test or reverse mutation assay to assess carcinogenicity.**	**K4**

COURSE CONTENT :

Experiment	**Total (60 hours)**
Preparation of solutions for Molecular Biology experiments.	
Isolation of chromosomal DNA from bacterial cells.	

Isolation of Plasmid DNA by alkaline lysis method	
Agarose gel electrophoresis of genomic DNA & plasmid DNA	
Preparation of restriction enzyme digests of DNA samples	
Demonstration of AMES test or reverse mutation for carcinogenicity	

Parasitology and **Immunology Lab (**TIU-UBT-MJ-L22202**)**

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title: Parasitology and **Immunology Lab**	**Subject Code:**TIU-UBT-MJ-L22202
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 2**

Course Objective:

1. Develop Fundamental Skills in Hematological Analysis

Train students in performing differential and total leucocyte counts, as well as total RBC counts, for immune system assessment.

Ensure proficiency in blood sample handling and accurate microscopic analysis of blood components.

2. Introduce Serological Techniques for Immune Response Assessment

Teach students the principles and applications of haemagglutination and haemagglutination inhibition assays.

Develop expertise in separating serum from blood for immunological testing.

3. Equip Students with Hands-on Experience in Immunodiagnostic Techniques

Provide practical training in immunodiffusion techniques for antigen-antibody interaction studies.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Explain the principles behind hematological tests, including differential leucocyte count, total leucocyte count, and total RBC count.	K1
CO2	Perform hematological assays to determine leucocyte and RBC counts accurately.	K2
CO3	Demonstrate serological techniques such as haemagglutination and haemagglutination inhibition assays.	K3
CO4	Isolate and separate serum from blood samples for immunological testing.	K3
CO5	Conduct double immunodiffusion tests to analyze antigen-antibody	K4

	interactions.	
CO6	Perform ELISA to detect specific antigens or antibodies, interpreting the results for diagnostic applications.	K4

COURSE CONTENT :

Experiment	**Total 60 hours**
Differential leucocytes count	
Total leucocytes count	
Total RBC count	
Hemagglutination assay	
Hemagglutination inhibition assay	
Separation of serum from blood	
Double immunodiffusion test using specific antibody and antigen	
ELIS	

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**3**
CO2	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Methods in Biology Lab (TIU-UBT-MI-L22201**)**

Program: B. Sc. in Biotech	**Year, Semester: 2ND** Yr., 4th Sem.
Course Title:Methods in Biology Lab	**Subject Code:**TIU-UBT-MI-L22201
Contact Hours/Week: 0-0-2 (L–T–P)	**Credit: 1**

Course Objective:

1. Develop Proficiency in Electrophoresis Techniques

Train students in protein separation methods using native gel electrophoresis and SDS-PAGE under reducing conditions.

Ensure understanding of protein migration, molecular weight determination, and data interpretation.

2. Equip Students with Skills in Cellular and Biochemical Analysis

Teach the preparation of sub-cellular fractions from rat liver cells and protoplast isolation from plant leaves.

Develop expertise in biochemical techniques for studying cellular components.

3. Introduce Chromatographic and Spectrophotometric Techniques

Provide hands-on experience in amino acid separation via paper chromatography and lipid identification using TLC.

Demonstrate the principles of spectrophotometry, including verification of Beer's law and determination of the molar extinction coefficient of NADH.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Explain the principles and techniques of electrophoresis for protein separation, including native and SDS-PAGE methods.	K1
CO2	Demonstrate the preparation of sub-cellular fractions from rat liver cells for biochemical analysis.	K2
CO3	Perform protoplast isolation from plant leaves using enzymatic digestion techniques.	K3
CO4	Apply chromatography techniques such as paper chromatography for amino acid separation and TLC for lipid identification.	K3
CO5	Analyze spectrophotometric data to verify Beer's law and determine the molar extinction coefficient of NADH.	K4
CO6	Evaluate and interpret experimental results obtained from electrophoresis, chromatography, and spectrophotometry for biological sample analysis.	K4

COURSE CONTENT

Experiment	**TOTAL (30 HOURS)**
Native gel electrophoresis of proteins	
SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.	
Preparation of the sub-cellular fractions of rat liver cells.	
Preparation of protoplasts from leaves.\	
Separation of amino acids by paper	

chromatography.	
To identify lipids in a given sample by TLC.	
To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.	

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2	2	1	1	2	1	2	2	2	3	2	3
CO 2	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 3	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 4	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 5	3	3	3	3	3	1	1	2	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3

PLANT CELL AND TISSUE CULTURE (TIU-UBT-MJ-T31301**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 5th Sem.
Course Title:PLANT CELL AND TISSUE CULTURE	**Subject Code:** TIU-UBT-MJ-T31301
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit: 4**

Course Objective:

1. Understand the Molecular and Genetic Basis of Plant Biotechnology
2. Introduce students to DNA molecular markers, gene mapping, genome analysis, and genetic transformation techniques.
3. Familiarize students with commonly used vectors, gene cloning strategies, and intellectual property rights (IPR) in plant biotechnology.
4. Develop Skills in Genetic Engineering and Stress Biology

5. Explore applications of plant tissue culture in bioprospecting, biofortification, secondary metabolite production, and cryopreservation.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Explain the principles and applications of DNA molecular markers, gene mapping, and genome analysis in plant biotechnology.	K1
CO2	Describe different gene cloning strategies, genetic transformation techniques, and risk assessment in plant biotechnology.	K2
CO3	Perform gene isolation, tissue-specific gene expression, and molecular analysis of genetically modified plants.	K3
CO4	Analyze molecular mechanisms of biotic and abiotic stress responses and their role in plant genetic engineering.	K4
CO5	Apply various plant tissue culture techniques such as somatic embryogenesis, anther culture, and somatic hybridization for crop improvement.	K3
CO6	Evaluate the role of plant biotechnology in secondary metabolite production, biofortification, cryopreservation, and RNAi technology.	K4

COURSE CONTENT :

MODULE 1:		**20 Hours**
DNA molecular markers; Principles, type and applications; RFLP, AFLP, RAPD, SSR, SNP, Structural and functional genomics, gene mapping, genome mapping, gene tagging and comparative genomics and applications, Restriction enzymes and their uses, Salient features of most commonly used vectors i.e. plasmids, bactetiophages, phagmids, cosmids, BACs and PACs, YACs, binary vectors, expression vectors, Gene cloning and sub-cloning strategies, chromosome walking, genetic transformation, Risk assessment and IP		
MODULE 2:		**20 Hours**
Isolation of genes of economic importance, Gene construction for tissue-specific expression, Different methods of gene transfer to plants, *viz.* direct and vector-mediated, Molecular analysis of transformants, Molecular biology of various stresses like drought, salt, heavy metals and temperature, and biotic stresses like bacterial, fungal and viral diseases, Signal transduction and its molecular basis, Potential applications of plant genetic engineering for crop improvement, i.e. insect-pest resistance, abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality, Current status of transgenics, biosafety norms and controlled field trials and release of transgenics (GMOs		
MODULE 3:		**20 Hours**
Basic techniques in cell culture and somatic cell genesis, Clonal propagation, Concept of cellular		

totipotency, Anther culture, Somaclonal and gametoclonal variations, Hybrid embryo culture and embryo rescue, Somatic hybridization and cybridization, Application of tissue 13 culture in crop improvement, Secondary metabolite production, Bioprospecting, Biofortification, Gene pyramiding and gene fusion, RNAi technology, *In vitro* mutagenesis, cryopreservation and plant culture repository	
TOTAL S	**60 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	1	2	1	1	2	1	2	2	2	3	2	2
CO 2	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 3	3	3	3	3	3	1	1	2	2	2	3	3	3	3	3
CO 4	3	3	3	2	3	1	1	2	2	2	3	3	3	3	3
CO 5	3	3	3	3	3	1	1	3	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3

Food Biotechnology (TIU-UBT-MJ-T31302**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 5th Sem.
Course Title:Food Biotechnology	**Subject Code:** TIU-UBT-MJ-T31302
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit: 4**

Course Objective:

1. To understand the principles of food biotechnology, including microbial fermentation, industrial enzymes, and genetic modifications, and their applications in improving food quality, safety, and nutrition.

2. To explore the role of biotechnology in food preservation, processing, and packaging, including biotechnological advancements in food safety, spoilage prevention, and sustainable packaging solutions.

3. To examine food quality control measures, safety regulations, and emerging trends in food biotechnology, such as functional foods, nutraceuticals, and sustainable biotechnological innovations for the food and pharmaceutical industries.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Explain the fundamental concepts of food biotechnology, including the role of microorganisms, fermentation, and industrial enzymes in food production.	K1
CO2	Describe the principles and applications of genetically modified (GM) foods, functional foods, and nutraceuticals in enhancing food security and human health.	K2
CO3	Apply biotechnological approaches to food preservation, food safety, and processing, including the use of antimicrobial compounds and foodborne pathogen detection techniques.	K3
CO4	Analyze food packaging innovations, including nanotechnology, edible films, and biodegradable materials for sustainable packaging solutions.	K4
CO5	Evaluate food quality control systems, food safety regulations, and biotechnological methods for detecting adulteration and ensuring food authenticity.	K4
CO6	Apply biotechnology in waste utilization, flavor enhancement, and emerging food trends such as lab-grown meat and sustainable food production.	K3

COURSE CONTENT :

MODULE 1:		**15 Hours**
Introduction to Food Biotechnology: Basics of Food Biotechnology: Scope, importance, and applications in the food industry. Microorganisms in Food Biotechnology: Role of bacteria, yeasts, molds, and fungi in food processing and fermentation. Food Fermentation: Principles and applications of microbial fermentation in producing dairy products (yogurt, cheese), beverages (beer, wine), and fermented foods (sauerkraut, soy products). Enzymes in Food Biotechnology: Industrial enzymes used in food processing (amylases, proteases, lipases), enzymatic modification of food products.Biotechnology in Food Production: Improving food yield, quality, and nutritional content through microbial fermentation and biotechnological processes.		
MODULE 2:		**15 Hours**
Genetically Modified Foods and Functional Foods Genetically Modified (GM) Foods: Definition, examples (Bt corn, Golden rice), and applications of GM crops in enhancing food security and nutrition. Techniques for GM Food Development: Genetic engineering methods, gene transfer techniques, CRISPR, and applications in modifying food crops for pest resistance,		

drought tolerance, and improved nutritional content. Functional Foods and Nutraceuticals: Definition, categories (probiotics, prebiotics, antioxidants, omega-3 fatty acids), and their health benefits. Biotechnology in Food Fortification: Enhancing food with vitamins, minerals, and bioactive compounds for improved health and nutrition. Regulation and Safety of GM Foods: Safety assessment protocols, public concerns, and labeling of GM foods.		
MODULE 3:		15 hours
Food Preservation, Processing, and Packaging: Biotechnological Approaches to Food Preservation: Role of natural antimicrobial compounds, bacteriocins, and biopreservation techniques in extending food shelf life. Food Spoilage and Safety: Microbial spoilage of food, detection of foodborne pathogens, and techniques to ensure food safety (PCR, ELISA). Food Processing Technologies: Biotechnological advancements in food processing (high-pressure processing, membrane filtration, irradiation). Food Packaging Innovations: Role of nanotechnology, edible films, and biodegradable materials in smart and active food packaging. Biotechnology in Waste Utilization: Valorization of food industry waste for the production of biofuels, bioactive compounds, and enzymes.		
Module 4		15 hours
Food Quality Control, Standards, and Regulations: Food Quality Control: Concepts of HACCP (Hazard Analysis and Critical Control Points), ISO standards, and food safety management systems. Food Adulteration and Biotechnology: Biotechnological methods for detecting food adulterants, food fraud prevention, and ensuring authenticity. Regulations and Compliance: National and international food safety regulations (FSSAI, FDA, EFSA), GMO labelling laws, and intellectual property rights in food biotechnology. Biotechnology in Flavour and Aroma Enhancement: Role of microbial cultures and enzymes in developing Flavors and aromas in food products. Future Trends in Food Biotechnology: Personalized nutrition, plant-based and lab-grown meat alternatives, sustainable food production using biotechnology.		
TOTAL LECTURES		**60Hours**

Course Articulation Matrix: (to be generated using campus.technology

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2	2	1	1	2	1	2	2	2	3	2	2
CO 2	3	2	2	2	2	1	1	2	1	2	2	2	3	2	2
CO 3	3	3	3	2	3	2	1	2	2	2	3	3	3	3	3
CO 4	3	3	3	3	3	3	2	2	2	3	3	3	3	3	3

CO 5	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3

Biostatistics (TIU-UBT-MI-T31203**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 5th Sem.
Course Title:Biostatistics	**Subject Code:** TIU-UBT-MI-T31203
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit: 4**

Course Objective:

1. To introduce fundamental statistical concepts and data analysis techniques, including data collection, classification, graphical representation, and measures of central tendency and dispersion.

2. To develop an understanding of probability and its applications in biological sciences, including probability distributions (Binomial, Poisson, and Normal) and their significance in data analysis.

3. To equip students with statistical inference and hypothesis testing methods, including t-tests, chi-square tests, ANOVA, correlation, and regression analysis for biological research applications.

COURSE OUTCOME :

CO No.	Course Outcome	
CO1	Define and classify different types of data, their sources, and methods of graphical representation.	K1
CO2	Explain and apply measures of central tendency, dispersion, skewness, and kurtosis in biological data analysis.	K2
CO3	Apply probability concepts and probability distributions (Binomial, Poisson, and Normal) to biological problems.	K3
CO4	Demonstrate methods of sampling, hypothesis testing, and statistical inference for biological research.	K3
CO5	Analyze biological data using statistical tests such as t-test, chi-square test, and ANOVA.	K4
CO6	Interpret correlation and regression analysis in biological research scenarios.	K4

COURSE CONTENT :

MODULE 1:		**15 Hours**
Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.		
MODULE 2:		**15 Hours**
Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.		
MODULE 3:		**15 Hours**
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)		
Module 4		15 hours
Correlation and Regression. Emphasis on examples from Biological Sciences		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**2**
CO 2	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**
CO 3	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO 4	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 5	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 6	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Bio separation and technology lab (TIU-UBT-MJ-L31351**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 5th Sem.
Course Title:Bioseparation technology lab	**Subject Code:** TIU-UBT-MJ-L31351
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1. To familiarize students with various cell disruption techniques (mechanical and non-mechanical) for the extraction of intracellular biomolecules.
2. To introduce fundamental bioseparation techniques such as centrifugation, chromatography, electrophoresis, and membrane filtration for the purification of biomolecules.
3. To develop analytical skills in protein purification and quantification using techniques like affinity chromatography, precipitation, dialysis, and spectrophotometry.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Understand fundamental principles of bioseparation techniques, including centrifugation, chromatography, and electrophoresis.	K1
CO2	Explain the mechanisms and applications of different cell disruption techniques for extracting intracellular biomolecules.	K2
CO3	Apply various chromatographic and precipitation methods for the purification and separation of proteins and nucleic acids.	K3
CO4	Analyze the efficiency of membrane filtration techniques for biomolecule concentration and contaminant removal.	K4
CO5	Evaluate protein purification strategies using affinity chromatography and electrophoresis.	K4
CO6	Perform protein quantification using spectrophotometric methods such as the Bradford and Lowry assays.	K3

COURSE CONTENT :

Experiment 1: Cell Disruption Techniques Introduction to mechanical and non-mechanical methods for cell disruption (sonication, homogenization, chemical lysis). Extraction of intracellular proteins from microbial cells.	**TOTAL 60 HOURS**
Experiment 2: Centrifugation Techniques Theory and applications of centrifugation in bioseparation. Differential centrifugation and density gradient centrifugation for separating cellular components.	
Experiment 3: Chromatography Techniques	

Paper Chromatography: Separation of amino acids or plant pigments. Thin Layer Chromatography (TLC): Separation of lipids or small molecules. Gel Filtration Chromatography: Separation of proteins based on molecular size. Ion Exchange Chromatography: Separation of proteins or nucleic acids based on charge.	
Experiment 4: Electrophoresis Techniques Agarose Gel Electrophoresis: Separation of DNA fragments by size. Polyacrylamide Gel Electrophoresis (SDS-PAGE): Separation and molecular weight determination of proteins.	
Experiment 5: Precipitation Techniques Protein precipitation using ammonium sulfate or organic solvents. Dialysis for removing small molecules from protein samples.	
Experiment 6: Membrane Filtration Techniques Use of ultrafiltration and microfiltration for concentrating proteins or removing contaminants from biological samples.	
Experiment 7: Affinity Chromatography Purification of enzymes or proteins using specific ligands bound to a solid support matrix. Elution of bound proteins and analysis of purity.	
Experiment 8: Protein Quantification Bradford or Lowry method for protein estimation. Spectrophotometric analysis of protein concentration.	

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**2**
CO 2	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO 3	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**3**
CO 4	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**2**	**3**
CO	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**

5															
CO 6	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**

Food and Pharmaceutical Biotechnology lab (TIU-UBT-MJ-L31302

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Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 5th Sem.
Course Title:Food and Pharmaceutical Biotechnology lab	**Subject Code:** TIU-UBT-MJ-L31302
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 2**

Course Objective:

1 To develop an understanding of microbial fermentation and enzyme activity for food and pharmaceutical applications, focusing on factors affecting fermentation processes and enzymatic reactions.

2. To equip students with hands-on experience in food preservation, bioactive compound extraction, and quality control techniques, enabling them to analyze food safety and pharmaceutical formulations.

2. To apply biotechnological methods in drug formulation, herbal medicine analysis, and pharmaceutical quality assessment, ensuring students gain practical skills for industrial and research applications.

COURSE OUTCOME :

CO No.	Course Outcome (COs)	
CO1	Understand the principles and processes of microbial fermentation and its role in food biotechnology.	K1
CO2	Explain the methods of enzyme isolation, activity assays, and their applications in food and pharmaceutical industries.	K2
CO3	Apply different food preservation techniques and assess their effectiveness in preventing microbial contamination.	K3
CO4	Analyze the extraction and characterization of bioactive compounds from plant and microbial sources.	K4
CO5	Evaluate the quality and safety of food and pharmaceutical products using microbiological and chemical analysis.	K4
CO6	Perform drug formulation techniques and assess the stability and potency of	K3

	pharmaceutical products.	

COURSE CONTENT :

Experiment 1: Microbial Fermentation Conduct fermentation processes using various microorganisms to produce fermented food products (e.g., yogurt, sauerkraut). Study the factors affecting fermentation (temperature, pH, time).	**TOTAL 60 HOURS**
Experiment 2: Enzyme Activity Assays Isolate enzymes from microbial or plant sources. Measure the activity of enzymes (e.g., amylase, protease) using spectrophotometric methods	
Experiment 3: Food Preservation Techniques Investigate various methods of food preservation (e.g., refrigeration, canning, pickling) and their effects on microbial growth. Conduct experiments to assess the effectiveness of preservatives	
Experiment 4: Extraction of Bioactive Compounds Extract bioactive compounds (e.g., antioxidants, flavonoids) from plant materials using various methods (solvent extraction, maceration). Analyze the extracted compounds using chromatography (TLC or HPLC).	
Experiment 5: Quality Control in Food Products Perform microbiological analysis of food samples for contamination (using plate count, coliform tests). Conduct chemical analysis for pH, acidity, and sugar content in food products.	
Experiment 6: Pharmacognosy and Herbal Medicine Study the extraction and analysis of bioactive compounds from medicinal plants. Evaluate the efficacy of herbal extracts using standard assays (e.g., antibacterial activity).	
Experiment 7: Drug Formulation Techniques Explore the preparation of pharmaceutical formulations (e.g., tablets, emulsions). Assess the physical and chemical properties of the formulated products	
Experiment 8: Quality Assessment of Pharmaceutical Products Conduct assays to determine the potency and purity of pharmaceutical samples. Analyze the stability of formulations under different storage conditions.	

Course Articulation Matrix: (to be generated using campus.technology

	PROGRAM OUTCOMES (PO)	**PROGRAM SPECIFIC**

													OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	2	2	1	2	1	2	2	2	3	1	2
CO2	3	2	2	2	2	1	1	2	1	2	2	2	3	2	2
CO3	3	3	3	2	3	3	1	2	2	3	2	3	3	2	3
CO4	3	3	3	2	3	2	1	3	2	3	3	3	3	2	3
CO5	3	3	3	2	3	3	1	3	2	3	3	3	3	2	3
CO6	3	3	3	2	3	2	1	3	2	3	3	3	3	2	3

INTERNSHIP (TIU-UBT-SEC-I3101**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 5th Sem.
Course Title: INTERNSHIP	**Subject Code:** TIU-UBT-SEC-I3101
Contact Hours/Week: 0-0-8 (L–T–P)	**Credit: 4**

Plant Biotechnology and Molecular Biology (TIU-UBT-MJ-T32301**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title:Plant Biotechnology and Molecular Biology	**Subject Code:** TIU-UBT-MJ-T32301
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1 To introduce students to fundamental plant tissue culture techniques, including micropropagation, organogenesis, and somatic embryogenesis, for plant propagation and improvement.

2 To explore advanced biotechnological methods, such as haploid production, protoplast isolation, and somatic hybridization, and their applications in crop improvement and genetic engineering.

3 To understand the role of plant growth-promoting bacteria in agriculture, including nitrogen fixation, biocontrol of pathogens, and plant growth enhancement through microbial interactions.

COURSE OUTCOME :

CO No.	Course Outcome (CO)	
CO1	Define fundamental concepts of plant tissue culture, including cryo and organogenic differentiation.	K1
CO2	Explain various micropropagation techniques and their applications in plant biotechnology.	K2
CO3	Apply knowledge of in vitro haploid production techniques for genetic improvement in plants.	K3
CO4	Analyze the process of protoplast isolation, fusion, and somatic hybridization for plant breeding.	K4
CO5	Evaluate the significance of somaclonal variation in plant biotechnology and its applications.	K4
CO6	Assess the role of plant growth-promoting bacteria in nitrogen fixation, biocontrol, and plant health improvement.	K4

COURSE CONTENT :

MODULE 1:		**12 Hours**
Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation. (15 Periods)		
MODULE 2:		**12 Hours**
In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesisSgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals. (20 Periods)		
MODULE 3:		**12 Hours**
Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages. (15 Periods)\		
Module 4		9 hours
Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria. (10 Periods)		
TOTAL LECTURES		**45 Hours**

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Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)	**PROGRAM SPECIFIC OUTCOMES**

													(PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO 2	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO 3	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 4	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 5	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 6	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Animal physiology (TIU-UBT-MJ-T32303)

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title: Animal physiology	**Subject Code:**TIU-UBT-MJ-T32303
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1 To introduce students to fundamental plant tissue culture techniques, including micropropagation, organogenesis, and somatic embryogenesis, for plant propagation and improvement.

2 To explore advanced biotechnological methods, such as haploid production, protoplast isolation, and somatic hybridization, and their applications in crop improvement and genetic engineering.

3 To understand the role of plant growth-promoting bacteria in agriculture, including nitrogen fixation, biocontrol of pathogens, and plant growth enhancement through microbial interactions.

COURSE OUTCOME :

CO No.	Course Outcome (CO)	
CO1	Describe the mechanisms of digestion, absorption, and respiration in animals.	K1
CO2	Explain the composition of blood, the process of blood coagulation, and the physiology of circulation.	K2

CO3	Illustrate the structure and functions of different muscle types and analyze the mechanism of muscle contraction.	K3
CO4	Examine the process of osmoregulation, urine formation, and different excretion modes in animals.	K4
CO5	Analyze the mechanism of nerve impulse conduction and the role of neurotransmitters in neural coordination.	K4
CO6	Evaluate the functions of endocrine glands, hormone action mechanisms, and disorders due to hormonal imbalances.	K4

COURSE CONTENT :

MODULE 1:		**15 Hours**
Digestion and Respiration (15 Period) Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.		
MODULE 2:		**15 Hours**
Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.		
MODULE 3:		**15 Hours**
Muscle physiology and osmoregulation (15 Period) Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, singlemuscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical &electricalevents of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.		
Module 4		15 hours
Nervous and endocrine coordination (18 Period) Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters Mechanism of action of hormones (insulin and steroids) Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.		
TOTAL LECTURES		**45 Hours**

Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**

1															
CO 2	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO 3	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 4	**3**	**3**	**3**	**2**	**3**	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 5	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO 6	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Recombinant DNA technology (TIU-UBT-MJ-T32302)

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title: Recombinant DNA technology	**Subject Code:** TIU-UBT-MJ-T32302
Contact Hours/Week: 3-1-0 (L–T–P)	**Credit: 4**

Course Objective:

1. To introduce the fundamental principles of recombinant DNA technology, including molecular tools, gene transfer techniques, and cloning vectors.

2. To develop an understanding of genome mapping, genetic engineering techniques, and their applications in animals, plants, and microbial systems.

3. To equip students with knowledge of advanced genetic manipulation techniques, including mutagenesis, protein engineering, and transgenic technology for biotechnological applications.

COURSE OUTCOME :

CO No.	Course Outcome (CO)	
CO1	Describe molecular tools such as restriction enzymes, ligases, polymerases, and their applications in genetic engineering.	K1
CO2	Explain various gene transfer techniques, including transformation, electroporation, and microinjection, and their role in recombinant DNA technology.	K2
CO3	Illustrate and compare genomic and cDNA libraries, andanalyze different screening techniques for recombinant selection.	K3
CO4	Analyze the principles and applications of DNA fingerprinting, restriction mapping, and hybridization techniques in genome mapping.	K4

CO5	Evaluate mutagenesis techniques such as random and site-directed mutagenesis and their role in protein engineering.	K4
CO6	Assess genetic engineering applications in plants and animals, including transgenic organisms and therapeutic protein production.	K4

COURSE CONTENT :

MODULE 1:		15 Hours
Molecular tools and applications- restriction enzymes, ligases, polymerases, alkalinephosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids andother cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection,Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR),primer-design, and RT- (Reverse transcription) PCR.		
MODULE 2:		15 Hours
Restriction and modification system, restriction mapping. Southern and Northern hybridization.Preparation and comparison of Genomic and cDNA library, screening of recombinants, reversetranscription,. Genome mapping, DNA fingerprinting, Applications of Genetic EngineeringGenetic engineering in animals: Production and applications of transgenic mice, role of ES cellsin gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins,human hormones, immune modulators and vaccines (one example each)		
MODULE 3:		10 Hours
Random and site-directed mutagenesis: Primer extension and PCR based methods of site directedmutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Proteinengineering concepts and examples (any two).		
Module 4		5 hours
Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, Tiplasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Genetargeting in plants, Use of plant viruses as episomal expression vectors.		
TOTAL LECTURES		45 Hours

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Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**		**2**							**2**	**3**	**2**	**3**
CO2	**3**	**3**	**2**	**2**	**2**							**2**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**2**							**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**				**1**	**1**	**1**	**3**	**3**	**3**	**3**

CO5	**3**	**3**	**3**	**3**	**3**				**1**	**1**	**1**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**3**	**3**	**2**			**2**	**2**					

GIS AND REMOTE SENSING (TIU-UBT-MI-T32201)

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title: GIS AND REMOTE SENSING	**Subject Code:**TIU-UBT-MI-T32201
Contact Hours/Week: 3-1-0 (L–T–P)	**Credit: 4**

Course Objective:

1. To introduce the fundamental principles of Geographic Information Systems (GIS) and Remote Sensing, including data models, coordinate systems, and image acquisition techniques.
2. To develop practical skills in GIS data analysis and remote sensing image processing, such as spatial analysis, thematic mapping, image classification, and change detection.
3. To explore the integration of GIS and remote sensing for real-world applications, including environmental monitoring, agriculture, urban planning, disaster management, and biodiversity conservation.

COURSE OUTCOME :

CO No.	**Course Outcome**	
CO1	**Define fundamental concepts of GIS and remote sensing, including spatial and non-spatial data, coordinate systems, and data models.**	**K1**
CO2	**Explain the principles of remote sensing, electromagnetic spectrum interactions, image acquisition techniques, and GIS data management processes.**	**K2**
CO3	**Apply GIS tools and remote sensing techniques to analyze spatial data, perform thematic mapping, and conduct spatial and geostatistical analysis.**	**K3**
CO4	**Utilize image processing techniques, including classification, change detection, and advanced image enhancement, for real-world applications.**	**K3**
CO5	**Examine the integration of GIS and remote sensing in various domains such as environmental monitoring, disaster management, and urban planning.**	**K4**
CO6	**Assess emerging trends in GIS and remote sensing, including AI, big data, UAVs, and IoT-based geospatial applications.**	

COURSE CONTENT :

MODULE 1:		**10 Hours**
Introduction to Geographic Information Systems (GIS) (10 Period) **Definition and Concepts**: Understanding GIS, spatial and non-spatial data, geographic phenomena. **Components of GIS**: Hardware, software, data, people, and methods. **Data Models in GIS**: Vector and raster data, attribute data, topology. **Coordinate Systems**: Geographic coordinate system, map projections, datum. **Data Input and Management**: Data sources, data entry (digitization, scanning), database management systems (DBMS).		
MODULE 2:		**10 Hours**
Remote Sensing: Principles and Basics (10 Period) **Definition and Overview**: Introduction to remote sensing and its importance. **Electromagnetic Spectrum**: Radiation principles, interaction with the atmosphere, energy sources and energy interactions with the Earth's surface. **Remote Sensing Platforms and Sensors**: Aerial and satellite platforms, types of sensors (optical, microwave, thermal), passive vs. active sensors. **Resolution**: Spatial, spectral, radiometric, and temporal resolutions. **Image Acquisition and Preprocessing**: Image calibration, correction for geometric and atmospheric distortions, image enhancement.		
MODULE 3:		**10 Hours**
Data Analysis in GIS (10 Period) **Spatial Analysis**: Overlay, buffer analysis, spatial interpolation, proximity analysis, and network analysis. **Thematic Mapping**: Cartographic representation, map symbols, and thematic layers. **Data Query and Manipulation**: Attribute-based queries, spatial queries, and map algebra. **Geostatistical Analysis**: Point pattern analysis, autocorrelation, and trend analysis		
Module 4		**10 Hours**
Remote Sensing Image Processing (10 Period) **Image Classification**: Supervised and unsupervised classification, training data, classification accuracy. **Change Detection**: Techniques for detecting changes in land cover, vegetation index, and other landscape features. **Image Interpretation**: Visual interpretation, digital image processing, and multispectral analysis. **Advanced Image Processing Techniques**: Principal component analysis (PCA), Fourier transform, and image fusion.		
MODULE 5		**10 Hours**
Integration of GIS and Remote Sensing (10 Period)		

Data Integration: Linking remote sensing data with GIS, raster-vector integration. **Applications of GIS and Remote Sensing**: **Environmental Monitoring**: Forest mapping, soil erosion, climate change. **Agriculture**: Precision farming, crop yield estimation, soil mapping. **Urban Planning**: Land-use mapping, infrastructure planning, transportation. **Disaster Management**: Flood mapping, landslide risk analysis, earthquake impact assessment. **Biodiversity and Wildlife Management**: Habitat analysis, species distribution, and conservation planning. **Case Studies**: Real-world examples of GIS and RS applications in various sectors.

MODULE 5		**10 Hours**
Future Trends in GIS and Remote Sensing		**(10 Period)**
Emerging Technologies: Artificial intelligence in remote sensing, machine learning for image analysis, deep learning applications. **Big Data and Cloud Computing in GIS**: Cloud-based GIS platforms, handling large datasets, real-time GIS analysis. **Unmanned Aerial Vehicles (UAVs) in Remote Sensing**: Use of drones in data collection and mapping. **Geospatial Technologies in IoT and Smart Cities**: Integration of GIS in smart city planning, sensors, and real-time monitoring.		
TOTAL S		**60 Hours**

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Course Articulation Matrix: (to be generated using campus.technology)

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**			**2**						**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**	**2**	**2**	**2**						**2**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**3**			**1**		**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**3**			**1**	**1**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**3**	**3**	**2**			**1**	**2**	**3**	**3**	**3**	**3**	**3**

Plant Biotechnology Lab (TIU-UBT-MJ-L32301**)**

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title:Plant Biotechnology Lab	**Subject Code:**TIU-UBT-MJ-L32301
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1. To develop practical skills in plant tissue culture techniques, including explant selection, sterilization, and inoculation for successful in vitro plant propagation.

2. To understand and perform callus culture, suspension culture, and induction of growth, focusing on meristematic tissues for plant regeneration and genetic studies.

3. To analyze and estimate biologically important plant products, including secondary metabolites, enzymes, and other bioactive compounds essential for plant physiology and biotechnology applications.

COURSE OUTCOME :

Course Outcome (CO)	**Description**	
CO1	Understand the principles and procedures for explant selection, sterilization, and inoculation in plant tissue culture.	**K1**
CO2	Demonstrate the ability to initiate and maintain callus culture from meristematic tissues and perform suspension culture techniques.	**K2**
CO3	Apply techniques for anther and pollen culture to develop haploid plants and study their significance in plant breeding.	**K3**
CO4	Analyze the factors affecting plant tissue growth and differentiation in vitro.	**K4**
CO5	Estimate and quantify biologically important plant products, including secondary metabolites, using biochemical methods.	**K3**
CO6	Evaluate the advantages and limitations of various plant biotechnology techniques for large-scale plant production.	**K4**

COURSE CONTENT :

Explant selection, sterilization and inoculation	**Total 60 hours**
Callus culture from meristimatic tissue and induction of growth, suspension culture	
Anther and Pollen culture	
Estimation of biologically important plant products	

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Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**		**2**	**2**					**1**	**2**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**3**	**2**					**2**	**2**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**2**			**1**		**2**	**3**	**3**	**3**	**3**

CO4	**3**	**3**	**3**	**3**	**3**	**2**			**1**	**1**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**2**					**2**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**3**	**3**	**2**			**2**	**2**	**3**	**3**	**3**	**3**	**3**

Mammalian physiology lab (TIU-UBT-MI-L32251)

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title: Mammalian physiology lab	**Subject Code:**TIU-UBT-MI-L32251
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1 To develop practical skills in hematological analysis, including blood coagulation time, blood grouping, and red blood cell (RBC) counting, for understanding mammalian circulatory physiology.

2 To train students in leukocyte differential counting (TLC & DLC) and hemoglobin estimation, enabling them to assess immune function and oxygen-carrying capacity in mammals.

3 To introduce students to enzymatic activity in physiological processes, through experiments demonstrating enzyme action and its role in metabolism.

COURSE OUTCOME :

CO No.	**Course Outcome (CO)**	
CO1	Recall the principles and procedures for hematological assessments, including blood coagulation, blood grouping, and RBC counting.	**K1**
CO2	Explain the physiological significance of total leukocyte count (TLC) and differential leukocyte count (DLC) in immune response and disease detection.	**K2**
CO3	Describe the role of hemoglobin in oxygen transport and its clinical importance, demonstrated through hemoglobin estimation.	**K2**
CO4	Perform laboratory techniques such as blood sample preparation, counting RBCs, and analyzinghematological parameters with accuracy.	**K3**
CO5	Demonstrate enzyme activity and interpret its role in metabolic processes through experimental analysis.	**K3**
CO6	Evaluate and compare physiological parameters such as blood coagulation time, leukocyte variation, and enzyme function in different biological conditions.	**K4**

COURSE CONTENT :

Finding the coagulation time of blood	**Total 60 hours**
Determination of blood groups	
Counting of mammalian RBCs	
Determination of TLC and DLC	
Demonstration of action of an enzyme	
Determination of Haemoglobin	

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**		**2**	**1**					**2**	**2**	**2**	**2**	**2**
CO2	**3**	**2**	**3**		**2**	**2**				**1**	**2**	**2**	**2**	**3**	**2**
CO3	**3**	**2**	**2**		**2**	**1**					**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**2**	**3**	**1**				**1**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**1**				**1**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**2**	**3**	**2**			**1**	**2**	**3**	**3**	**3**	**3**	**3**

Recombinant DNA technology LAB (TIU-UBT-MJ-L32302)

Program: B. Sc. in Biotech	**Year, Semester: 3rd** Yr., 6th Sem.
Course Title: Recombinant DNA technology LAB	**Subject Code:** TIU-UBT-MJ-L32302
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1 To develop skills in DNA isolation and purification techniques from plant and microbial sources for genetic analysis and molecular biology applications.

2 To introduce students to recombinant DNA techniques, including plasmid isolation, restriction digestion, and bacterial transformation, for genetic engineering experiments.

3 To familiarize students with molecular biology analytical tools, such as spectrophotometry and PCR, for qualitative and quantitative DNA analysis.

COURSE OUTCOME :

CO No.	Course Outcome (CO)	
CO1	**Demonstrate the isolation of chromosomal DNA from plant cells and E. coli.**	**K2**
CO2	**Perform qualitative and quantitative analysis of DNA using a spectrophotometer.**	**K3**
CO3	**Extract and purify plasmid DNA from bacterial cells.**	**K3**
CO4	**Conduct restriction digestion of DNA and analyze the results.**	**K3**
CO5	**Develop competent cells and perform transformation experiments.**	**K4**
CO6	**Explain the principles and applications of Polymerase Chain Reaction (PCR) through demonstration.**	**K2**

COURSE CONTENT :

Isolation of chromosomal DNA from plant cells	**Total 60 hours**
. Isolation of chromosomal DNA from *E.coli*	
Qualitative and quantitative analysis of DNA using spectrophotometer.	
Plasmid DNA isolation	
Restriction digestion of DNA	
Making competent cells	
Transformation of competent cells	
Demonstration of PCR	

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**		**3**						**2**	**2**	**3**	**2**	**3**
CO2	**3**	**3**	**3**		**3**						**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**2**		**3**						**3**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**					**1**	**3**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**				**1**	**1**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**2**	**2**		**2**						**2**	**2**	**3**	**2**	**3**

Genomics and proteomics and bioinformatics (TIU-UBT-MJ-T41401**)**

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 7thsem**
Course Title:Genomics and proteomics and bioinformatics	**Subject Code:**TIU-UBT-MJ-T41401

Contact Hours/Week: 3–1–0 (L–T–P)	**Credit: 4**

Course Objective:

1 To understand the principles and techniques of genome analysis, including gene prediction, sequencing methods, genome-wide association studies, and functional annotation in prokaryotic and eukaryotic systems.

2 To explore proteomics techniques, such as protein separation, identification using mass spectrometry, post-translational modifications, and their applications in functional and interaction proteomics.

3 To apply bioinformatics tools and databases for genome research, microarray data analysis, protein structure prediction, and system biology approaches to study biological networks.

Course outcomes

Course Outcome (CO)	**Description**	
CO1	**Explain the concepts of gene prediction, genome sequencing, and annotation techniques in prokaryotic and eukaryotic systems.**	**K2**
CO2	**Apply functional genomics approaches, such as sequence and structure-based methods, for gene function assignment.**	**K3**
CO3	**Analyze transcriptome data using databases, microarray technology, and computational tools for gene expression studies.**	**K4**
CO4	**Demonstrate knowledge of proteomics techniques, including 2D electrophoresis, mass spectrometry, and protein identification.**	**K2**
CO5	**Utilize bioinformatics tools and databases for genome and proteome analysis, structural predictions, and biological data interpretation.**	**K3**
CO6	**Evaluate the applications of genomics and proteomics in medicine, synthetic biology, bioengineering, and conservation.**	**K4**

COURSE CONTENT:

MODULE 1:		20 hours
GENE AND GENOME ANALYSIS: Gene prediction in prokaryotes and eukaryotes - Genome-wide association (GWA) analysis -Massively parallel Signature sequencing (MPSS), Whole genome Shotgun sequencing, Next Generation Sequencing (NGS) - Cytogenetic and physical mapping - GDB, NCBI, OMIM, NGI/MGD - Structural annotation - Functional annotation - Limitation of genomics **Functional genomics: Functional genomics: Application of sequence based and structure-based approaches to assignment of gene functions – e.g. sequence comparison, structure**		

analysis (especially active sites, binding sites) and comparison, pattern identification, etc. Developmental biology and Differential gene expression, Microarray analysis

Transcriptome Analysis: Databases and basic tools: Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases DNA microarray: understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches), RNA Sequencing Use of various derived databases in function assignment, use of SNPs for identification of genetic traits. Gene/Protein function prediction using Machine learning tools viz. Neural network, SVM etc.,
Applications of Genomics: Genomic medicine - Synthetic biology and bioengineering - Conservation genomics

MODULE 2:		**20 Hours**

PROTEOMICS

Protein chemistry to proteomics:

The proteomics workflow

Basic of separation sciences: Protein and peptides;

Two-dimensional electrophoresis (2-DE), Advancement in solubilization of hydrophobic proteins, development of immobilized pH gradient strips, gel casting, staining of gels and image analysis.

Two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Blue native PAGE (BN-PAGE), gel free proteomics methods. Protein identification by mass spectrometry: ESI-TOF, MALDI-TOF, MS/MS Post-translational modifications of proteins - Limitation of proteomics

MODULE 3:		**20 Hours**

BIOINFORMATICS

Module 1: Biological databases, Biological data sciences in genome research

Module 2: Human Genome Project, Microarray Technology

Module 3: Bioinformatics for Proteomics, Principles of protein structure, Torsion angles and Ramachandran Plot

Module 4: Ontologies and clustering

Module 5: System Biology and biological network

.BIOINFORMATICS (12 Period)

Module 1: Biological databases, Biological data sciences in genome research

Module 2: Human Genome Project, Microarray Technology

Module 3: Bioinformatics for Proteomics, Principles of protein structure, Torsion angles

and Ramachandran Plot **Module 4: Ontologies and clustering** **Module 5: System Biology and biological network**
TOTAL LECTURES **60 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**						**1**	**2**	**3**	**2**	**3**
CO2	**3**	**3**	**2**	**2**	**2**				**1**		**1**	**2**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**3**						**2**	**3**	**3**	**3**	**3**
CO4	**3**	**2**	**2**	**1**	**3**						**1**	**2**	**3**	**2**	**3**
CO5	**3**	**3**	**3**	**2**	**3**			**2**	**1**	**1**	**2**	**3**	**3**	**3**	**3**
CO6	**3**	**2**	**3**	**3**	**3**	**2**	**1**			**2**	**2**	**3**	**3**	**3**	**3**

Nanotechnology and tissue engineering (TIU-UBT-MJ-T41402)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 7thsem**
Course Title: Nanotechnology and tissue engineering	**Subject Code:**TIU-UBT-MJ-T41402
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit: 4**

Course Objective:

1. To introduce fundamental concepts of nanotechnology and biomaterials, including their synthesis, properties, and characterization techniques, with a focus on applications in biotechnology and medicine.

2/ To explore the role of nanomaterials in drug delivery, diagnostics, and tissue engineering, emphasizing their biomedical applications, biocompatibility, and potential for regenerative medicine.

3. To understand scaffold fabrication techniques and ethical, regulatory, and commercialization aspects of nanotechnology and biomaterial science for biomedical and industrial applications.

Course outcomes

Course Outcome (CO)	Description	
CO1	**Explain the fundamental concepts of nanotechnology, types of nanomaterials, their synthesis, properties, and characterization techniques.**	**K2**
CO2	**Analyze the role of nanomaterials in drug delivery, targeted therapies, nanotoxicity, and biomedical diagnostics.**	**K4**
CO3	**Describe the principles of tissue engineering, biomaterials used for scaffold development, and cellular interactions in tissue regeneration.**	**K2**
CO4	**Evaluate the application of nanomaterials in tissue engineering, including bone, neural, and wound healing applications.**	**K4**
CO5	**Apply knowledge of scaffold fabrication techniques, including electrospinning, 3D bioprinting, and hydrogel preparation, for tissue engineering applications.**	**K3**
CO6	**Discuss ethical, regulatory, and commercialization aspects of nanomaterials and tissue engineering in biomedical applications.**	**K2**

COURSE CONTENT :

MODULE 1:		10 hours
Introduction to Nanomaterials and Nanotechnology (10 Period) Introduction to Nanotechnology: Definition, history, and applications in biotechnology and medicine. Types of Nanomaterials: Nanoparticles, nanofibers, nanowires, carbon nanotubes, and quantum dots. Synthesis of Nanomaterials: Top-down vs. bottom-up approaches, chemical vapor deposition, sol-gel method, and electrospinning. Properties of Nanomaterials: Size-dependent properties (optical, mechanical, and electrical), surface chemistry, and bio-nano interactions. Characterization of Nanomaterials: SEM, TEM, AFM, DLS, XRD, and zeta potential analysis.		
MODULE 2:		10 hours
Nanomaterials in Drug Delivery and Medical Applications (10 Period) Nanocarriers for Drug Delivery: Liposomes, dendrimers, polymeric nanoparticles, metallic nanoparticles, and nanomicelles. Mechanisms of Drug Release: Controlled and targeted drug delivery systems, stimulus-responsive nanocarriers (pH, temperature, magnetic field). Nanomaterials in Cancer Therapy: Nanoparticles for drug delivery, photothermal therapy, and targeted cancer therapies. Nanotoxicity and Biosafety: Toxicity assessments of nanomaterials,		

nanomaterial-cell interactions, and regulatory guidelines for biomedical nanomaterials. Nanomaterials in Diagnostics: Quantum dots, gold nanoparticles, and nanobiosensors for disease diagnosis.

MODULE 3:		**8 Hours**

Fundamentals of Tissue Engineering

Tissue Engineering Overview: Definition, scope, and key components (cells, scaffolds, and growth factors). Biomaterials in Tissue Engineering: Natural (collagen, gelatin, chitosan) and synthetic materials (PLGA, PEG, PCL), biocompatibility, and biodegradability. Scaffold Design Principles: Structural properties of scaffolds, porosity, mechanical strength, and surface modification for cell attachment and growth. Cell Sources for Tissue Engineering: Stem cells (embryonic, adult, and induced pluripotent), progenitor cells, and primary cells. Growth Factors and Signaling Molecules: Role of cytokines, hormones, and ECM proteins in tissue regeneration.

Module 4		10 hours

Nanostructured Scaffolds: Nanofibrous scaffolds, nanocomposites, and their role in enhancing cell proliferation and differentiation. Nanomaterials for Bone Tissue Engineering: Hydroxyapatite nanoparticles, bioactive glass, and composites for bone regeneration. Nanomaterials in Skin and Wound Healing: Nanofibers, hydrogels, and nano-based dressings for accelerated tissue repair. Nanotechnology in Neural Tissue Engineering: Conductive nanomaterials for nerve regeneration, nerve guidance conduits, and applications in neuroprosthetics. Smart Biomaterials: Stimuli-responsive scaffolds (temperature, pH, and magnetic field) and their applications in controlled tissue regeneration.

Module 5		10 hours

Scaffold Fabrication Techniques and Applications (10 Period)

Scaffold Fabrication Techniques: Electrospinning, 3D bioprinting, freeze-drying, solvent casting, and self-assembly methods. Hydrogels in Tissue Engineering: Hydrogel properties, fabrication, and applications in soft tissue regeneration. 3D Bioprinting: Overview, bioinks, and 3D-printed scaffolds for organ and tissue regeneration. Applications in Tissue Engineering: Bone and cartilage regeneration, cardiovascular tissue engineering, skin regeneration, and organoid development. Bioreactors in Tissue Engineering: Role of bioreactors in dynamic culture environments, improving scaffold-cell interactions, and tissue maturation

Module 6		10 hours

Ethical, Regulatory, and Commercial Aspects of Nanomaterials and Tissue Engineering (10 Period)

Ethical Considerations: Ethical challenges in tissue engineering, use of stem cells, and

nanomaterials in medicine. Regulatory Guidelines: FDA and EMA guidelines for nanomaterials and tissue-engineered products, clinical trials, and safety assessments. Nanotechnology in Commercialization: Patenting issues, intellectual property rights, commercialization challenges, and market potential of tissue-engineered products. Future Trends and Innovations: Emerging trends in nanotechnology and tissue engineering, advancements in 4D bioprinting, and synthetic biology applications.

TOTAL LECTURES	**60 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**						**1**	**2**	**3**	**2**	**3**
CO2	**3**	**3**	**3**	**2**	**3**	**2**				**1**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**2**	**2**	**1**	**2**						**1**	**2**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**1**			**2**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**3**	**3**	**1**			**1**	**1**	**2**	**3**	**3**	**3**	**3**
CO6	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**2**		**3**	**3**	**3**	**2**	**2**	**2**

Agricultural biotechnology (TIU-UBT-MI-T41301)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 7thsem**
Course Title: Agricultural biotechnology	**Subject Code:**TIU-UBT-MI-T41301
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit: 2**

Course Objective:

1. To introduce fundamental concepts of agricultural biotechnology, including traditional and modern approaches to crop improvement, genetic engineering, and molecular breeding techniques.

2 To explore the applications of biotechnology in sustainable agriculture, including the development of transgenic crops, biofertilizers, biopesticides, and climate-resilient crop varieties.

3 To understand the role of biotechnology in addressing global agricultural challenges, such as food security, environmental sustainability, and improved crop productivity through genetic modification and advanced breeding techniques.

Course outcomes

CO	**Course Outcome (CO)**	

No.		
CO1	**Define the fundamental concepts of agricultural biotechnology, including traditional vs. modern agricultural practices and genetic improvement techniques.**	**K1**
CO2	**Explain the role of molecular breeding, transgenic crops, and genetic engineering methods such as Agrobacterium-mediated transformation and CRISPR-Cas9 in crop improvement.**	**K2**
CO3	**Discuss the impact of agricultural biotechnology on food security, environmental sustainability, and global agricultural challenges.**	**K2**
CO4	**Demonstrate the applications of biofertilizers, biopesticides, and microbial inoculants in sustainable agriculture for improving soil fertility and disease resistance.**	**K3**
CO5	**Utilize molecular markers and marker-assisted selection (MAS) techniques for stress-tolerant and disease-resistant crop development.**	**K3**
CO6	**Evaluate the benefits and challenges of genetically modified (GM) crops, including their environmental impact, regulatory concerns, and future potential in sustainable agriculture.**	**K4**

COURSE CONTENT :

MODULE 1:		10 hours
Introduction to Agricultural Biotechnology: Overview of Agricultural Biotechnology: Definition, history, and scope. Traditional vs. Modern Agriculture: Green revolution, plant breeding, and the role of biotechnology in modern agriculture. Genetic Basis of Crop Improvement: Mendelian genetics, quantitative trait loci (QTL), and molecular markers in plant breeding. Applications of Agricultural Biotechnology: Pest-resistant crops, herbicide-tolerant crops, drought-resistant crops, and biofortified crops. Global Impact: Biotechnology in addressing food security, crop productivity, and environmental sustainability. (10 Period)		
MODULE 2:		**10 Hours**
Genetic Engineering and Transgenic Crops: Introduction to Plant Genetic Engineering: Basic tools of genetic engineering (vectors, gene cloning, and gene transfer techniques). Methods of Gene Transfer: Agrobacterium-mediated transformation, biolistics (gene gun), and electroporation. Transgenic Crops: Bt crops, herbicide-tolerant crops, virus-resistant crops, and their commercial applications. Molecular Breeding and Marker-Assisted Selection (MAS): Role of molecular markers in crop improvement, MAS in developing stress-tolerant and disease-resistant crops. Gene Editing Technologies: CRISPR-Cas9 and its applications in crop genome Modification. (10 Period)		
MODULE 3:		**10 Hours**

Agricultural Biotechnology for Sustainable Agriculture: Biotechnology for Crop Disease Management: Development of resistant varieties through genetic engineering, RNAi, and biocontrol agents. Biofertilizers and Biopesticides: Microbial inoculants, nitrogen-fixing bacteria, and the role of biofertilizers in sustainable farming. Biotechnology for Soil Health Improvement: Bioremediation of contaminated soils, microbial management for nutrient recycling, and improving soil fertility using biotechnology. Genetically Modified (GM) Crops in Sustainable Agriculture: Environmental impact, reduced chemical use, and challenges related to GM crops. Climate-Resilient Crops: Developing crops resistant to drought, salinity, and extreme temperatures using biotechnology. (10 Period)	
TOTAL LECTURES	**30 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**1**					**1**	**2**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**3**	**1**				**1**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**1**	**2**	**3**	**2**			**2**	**1**	**3**	**2**	**2**	**2**
CO4	**3**	**2**	**2**	**2**	**3**	**3**				**1**	**1**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**2**	**3**	**2**			**1**	**1**	**2**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**		**3**	**2**	**3**	**2**	**3**	**3**

MULTI OMICS TECHNIQUE LAB (TIU-UBT-MJ-L41401**)**

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 7thsem**
Course Title:MULTI OMICS TECHNIQUE LAB	**Subject Code:**TIU-UBT-MJ-L41401
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1. To provide hands-on experience in multiomics techniques including genomic DNA and RNA extraction, protein isolation, and metabolite profiling, ensuring proficiency in laboratory protocols.

2 To develop analytical skills in molecular biology and bioinformatics, enabling students to assess DNA, RNA, and protein quality, perform qPCR, SDS-PAGE, and LC-MS/MS, and integrate multiomics data.

3 To equip students with data interpretation and problem-solving abilities for analyzingmultiomics datasets, correlating genomic, transcriptomic, proteomic, and metabolomic insights for biological research applications.

Course outcomes

CO No.	Course Outcome (CO)	
CO1	**Recall fundamental techniques in genomics, transcriptomics, proteomics, and metabolomics used in biological research.**	**K1**
CO2	**Explain the principles and methodologies involved in DNA, RNA, and protein extraction, along with their quality assessments.**	**K2**
CO3	**Demonstrate the process of cDNA synthesis and qPCR to analyze gene expression in biological samples.**	**K3**
CO4	**Perform SDS-PAGE and LC-MS/MS techniques for protein and metabolite analysis in biological samples.**	**K3**
CO5	**Utilize bioinformatics tools to integrate and analyze multi-omics data from genomics, transcriptomics, proteomics, and metabolomics.**	**K3**
CO6	**Analyze and interpret multi-omics data to derive meaningful biological insights and correlations between different molecular levels.**	**K4**

COURSE CONTENT :

Experiment 1: Genomic DNA Isolation Isolation of genomic DNA from plant or microbial samples. Quality assessment of isolated DNA using spectrophotometry and agarose gel electrophoresis.	**Total 60 hours**
Experiment 2: RNA Extraction and Quantification Extraction of total RNA from plant or animal tissues. Assessment of RNA quality and quantity using gel electrophoresis and spectrophotometric methods.	
Experient 3: cDNA Synthesis and qPCR Synthesis of complementary DNA (cDNA) from RNA samples. Performing quantitative PCR (qPCR) to analyze gene expression levels.	
Experiment 4: Protein Extraction and SDS-PAGE Extraction of proteins from biological samples. Separation of proteins using SDS-PAGE and visualization through Coomassie staining.	
Experiment 5: LC-MS/MS for Metabolomics Sample preparation for liquid chromatography-tandem mass spectrometry (LC-MS/MS). Analysis of metabolite profiles in biological samples.	
Experiment 6: Data Integration and Analysis	

Use of bioinformatics tools to integrate and analyze data from genomics, transcriptomics, proteomics, and metabolomics. Interpretation of multi-omics data to identify key biological insights.	

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**		**2**						**1**	**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**		**3**					**1**	**1**	**2**	**3**	**2**	**3**
CO3	**3**	**3**	**2**	**1**	**3**					**1**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**2**	**1**	**3**					**1**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**				**1**	**2**	**2**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**2**	**3**				**1**	**2**	**3**	**3**	**3**	**3**	**3**

Nanotechnology Lab (TIU-UBT-MJ-L41402)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 7thsem**
Course Title: Nanotechnology Lab	**Subject Code:**TIU-UBT-MJ-L41402
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1. To introduce students to nanoparticle synthesis techniques – Provide hands-on experience in the synthesis of silver and gold nanoparticles using different methods.

2. To familiarize students with nanoparticle characterization techniques – Train students in the use of UV-Vis spectroscopy, microscopy, and stability testing for analyzing nanoparticle properties.

3 To explore the biomedical applications of nanotechnology – Demonstrate the role of nanoparticles in drug delivery systems and their significance in biotechnology and medicine.

Course outcomes

Course Outcome (CO)	**Description**	
CO1	Describe the fundamental principles of nanoparticle synthesis and characterization techniques.	**K1**
CO2	Explain the role of UV-Vis spectroscopy and microscopy in nanoparticle characterization.	**K2**
CO3	Perform hands-on synthesis of silver and gold nanoparticles and assess their physicochemical properties.	**K3**

CO4	Analyze nanoparticle stability using laboratory techniques and evaluate their biocompatibility.	**K4**
CO5	Compare different microscopy techniques for nanoparticle observation and characterization.	**K4**
CO6	Demonstrate the application of nanoparticles in drug delivery systems and biomedical applications.	**K3**

COURSE CONTENT :

Experiment 1: Synthesis of Silver Nanoparticles	**Total 60 hours**
Experiment 2: Characterization of Nanoparticles using UV-Vis Spectroscopy	
Experiment 3: Synthesis of Gold Nanoparticles	
Experiment 4: Microscopy Techniques for Nanoparticle Observation	
Experiment 5: Nanoparticle Stability Testing	
Experiment 6: Applications of Nanoparticles in Drug Delivery	

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**		**2**					**1**	**1**	**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**		**3**					**1**	**1**	**2**	**3**	**2**	**2**
CO3	**3**	**3**	**2**	**1**	**3**	**1**			**1**	**2**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**2**			**1**	**2**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**2**	**3**	**2**	**2**					**1**	**2**	**3**	**3**	**2**	**3**
CO6	**3**	**3**	**3**	**3**	**3**	**2**		**1**	**1**	**2**	**3**	**3**	**3**	**3**	**3**

Research Project (TIU-UBT-SEC-P4101)

Program: B. Sc. in Biotech	**Year, Semester:** 3RD Yr., 5th Sem.
Course Title: Research Project	**Subject Code:**TIU-UBT-SEC-P4101
Contact Hours/Week: 0–0–8 (L–T–P)	**Credit: 4**

Course Objectives:

1. To provide hands-on research experience in biotechnology.
2. To develop scientific inquiry, problem-solving, and analytical skills.
3. To enhance the ability to plan, execute, and report a research project.

4. To improve communication skills through presentations and report writing.

Course outcomes:

CO Number	Course Outcome	Knowledge Level
CO1	Demonstrate the ability to identify a relevant research problem in biotechnology.	K2
CO2	Apply biotechnological techniques and tools in experimental work.	K3
CO3	Analyze and interpret experimental data using appropriate methods.	K4
CO4	Formulate conclusions based on scientific data and observations.	K4
CO5	Communicate research findings effectively through written reports and oral presentations.	K3
CO6	Work effectively as part of a research team, demonstrating responsibility and initiative.	K3

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3	2	3	1	1			2	3	3	2	3	3
CO2	3	3	2	2	3	1				2	3	3	3	3	3
CO3	3	3	3	2	3	1				2	3	3	3	3	3
CO4	3	3	3	2	3	1				3	3	3	3	3	3
CO5	2	2	2	1	2			3	2	2	3	3	2	2	2
CO6	2	3	2	2	2		1	2	3	3	3	3	2	3	2

Animal Biotechnology (TIU-UBT-MJ-T42401)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8th sem**
Course Title: Animal Biotechnology	**Subject Code** TIU-UBT-MJ-T42401
Contact Hours/Week: 3-1-0 (L–T–P)	**Credit: 4**

Course Objective:

1 To provide fundamental knowledge of animal cell culture techniques – Introduce students to laboratory requirements, aseptic techniques, cell culture types, characterization, and maintenance of cell lines.

2 To educate students on animal diseases and their management – Explain disease diagnosis, therapy, transmission modes, and strategies for disease control and prevention.

3 To explore advanced techniques in animal biotechnology – Cover stem cell manipulation, transgenic animal production, gene modification methods, and ethical considerations in biotechnology.

Course outcomes

CO No.	**Course Outcome (CO)**	
CO1	**Explain the fundamental concepts and laboratory techniques of animal cell culture, including aseptic handling and sterilization methods.**	**K1**
CO2	**Describe various types of cell cultures, cell separation techniques, and characterization of cell lines for biotechnological applications.**	**K2**
CO3	**Apply techniques for scaling up cell culture, cryopreservation, and viability assays to maintain and utilize cell lines effectively.**	**K3**
CO4	**Analyze the principles of disease transmission, diagnosis, and control measures for managing infectious diseases in animals.**	**K4**
CO5	**Demonstrate an understanding of stem cell technology, including embryo micromanipulation and transgenic animal development.**	**K3**
CO6	**Evaluate ethical concerns, regulatory aspects, and the impact of transgenic animals in biotechnology and biomedical research.**	**K4**

COURSE CONTENT :

MODULE 1:		20 hours
Animal cell culture, basic principles, Laboratory requirements for animal cell culture: Sterile handling area, Sterilization of different materials used in animal cell culture, Aseptic concepts, Instrumentation and equipments for animal cell culture, History of cell culture, Primary and secondary cell culture, serum free and serum based media, scaling-up, characterization and preservation of cell lines, cytotoxicity and viability assays, Different types of cell cultures, Trypsinization, Cell separation, Continuous cell lines, Suspension culture, Organ culture, Development of cell lines, Characterization and maintenance of cell lines, stem cells, Cryopreservation, Common cell culture contaminants. (25 Period)		
MODULE 2:		**20 Hours**
Animal diseases, diagnosis, therapy, variations of diseases, modes of transmission of diseases, control and management of disease spreading.		
MODULE 3:		**20 Hours**

Stem cells, micromanipulation of embryos, generation of modified stem cells, transgenic animals, retroviruses and DNA microinjection method, transgenic mice, cattle, knock in and knock out animals, Importance of transgenic animals in biotechnology and ethical issues, valuable genes for animal biotechnology. (20 Period)	
TOTAL LECTURES	**60 Hours**

Medical and pharmaceutical biotechnology (TIU-UBT-MJ-T42402)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8thsem**
Course Title: Medical and pharmaceutical biotechnology	**Subject Code**TIU-UBT-MJ-T42402
Contact Hours/Week: 3-1-0 (L–T–P)	**Credit: 4**

Course Objective:

1 To provide foundational knowledge of microbial pathogens, their morphology, pathogenesis, virulence factors, and laboratory diagnosis in relation to human health.

2. To explore various infectious diseases caused by bacteria, viruses, fungi, and protozoa, along with their transmission, symptoms, preventive measures, and therapeutic strategies.

3 To develop an understanding of biosafety measures, antimicrobial chemotherapy, and modern pharmaceutical approaches for disease diagnosis and treatment.

Course outcomes

CO No.	Course Outcome (CO)	
CO1	Define key concepts of medical microbiology, including normal microflora, nosocomial infections, and microbial pathogenicity.	**K1**
CO2	Describe the morphology, pathogenesis, symptoms, and diagnosis of bacterial infections caused by gram-positive and gram-negative bacteria.	**K2**
CO3	Explain the molecular mechanisms of viral infections, including those caused by retroviruses, hepatitis viruses, and orthomyxoviruses.	**K2**
CO4	Analyze fungal and protozoan infections, their pathogenicity, laboratory diagnosis, and therapeutic approaches.	**K4**
CO5	Apply knowledge of biosafety levels and antimicrobial strategies to assess disease prevention and control measures.	**K3**
CO6	Evaluate modern pharmaceutical approaches in diagnosing and treating bacterial, viral, fungal, and protozoan infections.	**K4**

COURSE CONTENT :

MODULE 1:		20 hours
Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriaeM.tuberculosis, M. leprae.		
MODULE 2:		**20 Hours**
Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.		
MODULE 3:		**20 Hours**
Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.		
Module 3		**20 hours**
Fungal and Protozoan infections. Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**–**	**2**	**1**	**–**	**1**	**–**	**1**	**2**	**2**	**3**	**2**	**3**
CO2	**3**	**2**	**2**	**–**	**2**	**1**	**–**	**1**	**–**	**1**	**2**	**2**	**3**	**2**	**3**
CO3	**3**	**2**	**2**	**1**	**2**	**1**	**–**	**1**	**–**	**1**	**2**	**2**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**2**	**–**	**2**	**–**	**2**	**2**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**2**	**–**	**2**	**1**	**3**	**2**	**2**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

IPR (TIU-UBT-MI-T42301**)**

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8t^{h}sem**
Course Title:IPR	**Subject Code**TIU-UBT-MI-T42301

Contact Hours/Week: 3-1-0 (L–T–P)	**Credit: 4**

Course Objective:

1. To provide an understanding of Indian patent laws, World Trade Organization (WTO) provisions, and the role of intellectual property in research, design, and development.
2. To introduce entrepreneurship concepts related to product selection, development, regulatory frameworks, and economic considerations in biotechnology-based industries.
3. To develop awareness about bioethics, biosafety, and regulatory guidelines, including Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP), for safe and ethical biotechnology applications.

COURSE OUTCOMES

CO No.	**Course Outcome (CO)**	
CO1	**Recall fundamental concepts of Indian Patent Law, WTO provisions, and intellectual property rights in biotechnology.**	**K1**
CO2	**Explain the significance of intellectual property protection in research, design, and development, including economic and ethical considerations.**	**K2**
CO3	**Apply knowledge of entrepreneurship by evaluating product selection, design, economic feasibility, and regulatory compliance.**	**K3**
CO4	**Discuss the necessity of bioethics, national and international paradigms, and ethical concerns in molecular biotechnology.**	**K2**
CO5	**Implement biosafety measures, containment levels, and good laboratory and manufacturing practices in biotechnological research.**	**K3**
CO6	**Analyze the impact of intellectual property rights, bioethics, and biosafety regulations on biotechnology innovation and commercialization.**	**K4**

COURSE CONTENT :

MODULE 1:		15 hours
Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations		
MODULE 2:		**15 Hours**
Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.		

MODULE 3:		**15 Hours**
Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.		
Module 4		**15 hours**
Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP)		
TOTAL LECTURES		**60 Hour**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**–**	**2**	**1**	**1**	**1**	**–**	**2**	**2**	**2**	**2**	**2**	**2**
CO2	**3**	**2**	**3**	**2**	**2**	**–**	**1**	**2**	**1**	**3**	**2**	**2**	**2**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**–**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**2**	**2**	**3**	**2**	**2**	**1**	**1**	**2**	**–**	**3**	**2**	**2**	**2**	**2**	**2**
CO5	**2**	**2**	**2**	**2**	**3**	**2**	**–**	**2**	**1**	**3**	**2**	**2**	**3**	**2**	**3**
CO6	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

Research Project (TIU-UBT-SEC-P4201)

Program: B. Sc. in Biotech	**Year, Semester:** 3RD Yr., 8th Sem.
Course Title: Research Project	**Subject Code:**TIU-UBT-SEC-P4201
Contact Hours/Week: 0–0–16 (L–T–P)	**Credit: 8**

Course Objectives:

1.To familiarize students with scientific literature, data collection and interpretation.

2. To improve students' abilities in scientific writing and communication.

3. To enhance students' critical thinking and problem-solving abilities.

CO Number	Course Outcomes	Knowledge levels
CO1	Identify relevant research problems and formulate hypotheses.	K2
CO2	Conduct literature review and develop an appropriate methodology.	K3
CO3	Implement experiments using laboratory techniques and procedures.	K3
CO4	Demonstrate experiments and validation of results	K4
CO5	Analyze experimental data using statistical and graphical tools.	K4
CO6	Prepare comprehensive scientific reports and communicate findings.	K3

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3	2	3	–	1	–	–	2	2	3	2	3	3
CO2	2	3	3	2	3	–	–	–	–	2	2	3	2	3	3
CO3	3	3	2	2	3	1	–	–	–	2	3	3	3	3	3
CO4	3	3	3	2	3	–	–	2	1	2	3	3	3	3	3
CO5	3	2	3	2	3	–	–	–	–	2	3	3	2	3	3
CO6	3	2	2	2	3	–	1	3	2	2	3	3	2	2	3

Ecology and evolution (TIU-UBT-MJ-T42403)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8thsem**
Course Title: Ecology and evolution	**Subject Code**TIU-UBT-MJ-T42403
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1.To develop an understanding of ecological principles and ecosystem dynamics, including energy flow, nutrient cycling, species interactions, and ecological succession.

2. To explore population ecology and evolutionary biology, focusing on population dynamics, species interactions, natural selection, genetic mechanisms, and speciation.

3. To analyze biodiversity conservation strategies and human impact on ecosystems, emphasizing conservation biology, ecological restoration, and evolutionary perspectives in conservation.

Course outcomes

CO No.	Course Outcome (CO)	
CO1	**Recall fundamental concepts of ecology, ecosystem dynamics, ecological interactions, and succession.**	**K1**
CO2	**Explain population ecology principles, species interactions, and the impact of human activities on biodiversity.**	**K2**
CO3	**Apply evolutionary biology concepts, including natural selection, genetic mechanisms, and speciation, to understand biodiversity patterns.**	**K3**
CO4	**Analyze the role of ecological and evolutionary processes in species adaptation and ecosystem functioning.**	**K4**
CO5	**Evaluate conservation strategies, biodiversity management, and ecological restoration methods for sustainable ecosystems.**	**K4**
CO6	**Assess the evolutionary impact of human activity on ecosystems, biodiversity, and species adaptation over time.**	**K4**

COURSE CONTENT :

MODULE 1:		20 hours
Introduction to Ecology and Ecosystem Dynamics: Basic Concepts of Ecology: Definition, scope, and history of ecology. Levels of Ecological Organization: Individual, population, community, ecosystem, biome, and biosphere. Ecosystem Structure and Function: Components of ecosystems, energy flow (trophic levels, food chains, food webs), and nutrient cycling (carbon, nitrogen, phosphorus cycles). Ecological Interactions: Competition, predation, parasitism, mutualism, and commensalism. Ecological Succession: Primary and secondary succession, factors influencing succession, and community dynamics.		
MODULE 2:		**20 Hours**
Population Ecology and Species Interactions Population Dynamics: Population growth models (exponential and logistic growth), carrying capacity, and factors regulating population size (density-dependent and independent factors). Population Structure: Age distribution, sex ratio, survivorship curves, and life history strategies (r and K selection). Metapopulations and Dispersal: Concept of metapopulations, habitat fragmentation, and migration. Species Interactions: Keystone species, niche theory, and competitive exclusion principle. Human Impact on Populations: Overexploitation, habitat destruction, and climate change impacts on biodiversity and populations.		
MODULE 3:		**20 Hours**
Evolutionary Biology and Natural Selection: Introduction to Evolution: History of evolutionary thought, Darwin’s theory of natural selection, and modern synthesis. Mechanisms of Evolution: Genetic drift, gene flow, mutation, natural selection, and sexual selection. Speciation and Extinction: Types of speciation (allopatric, sympatric), adaptive radiation, and factors leading to extinction. Evolution of Populations: Hardy-Weinberg equilibrium, factors disrupting genetic		

equilibrium, and the concept of fitness. Evolutionary Adaptations: Behavioral, morphological, and physiological adaptations in organisms		
Module 3		**20 hours**
Ecology, Evolution, and Conservation: Biodiversity and Ecosystem Services: Definition, importance of biodiversity, and its role in ecosystem stability. Conservation Biology: Principles of conservation, in-situ and ex-situ conservation, endangered species, and biodiversity hotspots. Ecological Restoration: Rewilding, habitat restoration, and management of ecosystems for conservation. Evolutionary Perspectives in Conservation: Phylogenetics in conservation, genetic diversity, and evolutionary responses to environmental changes. Human Evolution and Ecology: Evolution of Homo sapiens, human adaptations, and impacts of human activity on global ecosystems.		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**3**	**2**	**–**	**–**	**2**	**2**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**–**	**–**	**2**	**2**	**3**	**2**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**–**	**–**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**–**	**–**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**3**
CO6	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**–**	**–**	**3**	**3**	**3**	**2**	**3**	**3**

Developmental Biology (TIU-UBT-MI-T42302)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8t^{h}sem**
Course Title: Developmental Biology	**Subject Code**: TIU-UBT-MI-T42302
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1 To understand the fundamental concepts of developmental biology, including gametogenesis, fertilization, and the classification of eggs based on yolk composition.

2 To explore early embryonic development and differentiation, focusing on cleavage, blastulation, gastrulation, germ layer formation, and embryonic induction.

3 Toanalyze organogenesis and developmental processes, including neurulation, notogenesis, placental development, and the role of genetic and environmental factors in embryonic differentiation.

Course outcomes

CO No.	Course Outcome (CO)	
CO1	Recall fundamental concepts of developmental biology, including gametogenesis, fertilization, and types of eggs.	K1
CO2	Explain the processes of early embryonic development, including cleavage, blastulation, gastrulation, and germ layer formation.	K2
CO3	Illustrate the mechanisms of embryonic differentiation, including cell commitment, embryonic induction, and neural development.	K3
CO4	Analyze the process of organogenesis, including neurulation, notogenesis, and vertebrate eye development.	K4
CO5	Evaluate the role of genetic and environmental factors in embryonic development, differentiation, and adaptation.	K4
CO6	Assess the significance of extra-embryonic structures such as placental development and their role in mammalian development.	K4

COURSE CONTENT :

MODULE 1:		20 hours
Gametogenesis and Fertilization **Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.**		
MODULE 2:		**20 Hours**
Early embryonic development **Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.**		
MODULE 3:		**20 Hours**
Embryonic Differentiation **Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.**		
Module 3		**20 hours**
Organogenesis Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of		

behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.	
TOTAL LECTURES	**60 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**–**	**–**	**–**	**–**	**1**	**2**	**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**	**2**	**2**	**–**	**–**	**–**	**–**	**1**	**2**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**–**	**1**	**1**	**1**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**–**	**–**	**–**	**–**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**–**	**–**	**3**	**3**	**3**	**3**	**3**	**3**
CO6	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**–**	**–**	**2**	**2**	**3**	**2**	**2**	**2**

Environmental management and bioremediation (TIU-UBT-MI-T42303

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Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8t^{h}sem**
Course Title: Environmental management and bioremediation	**Subject Code**TIU-UBT-MI-T42303
Contact Hours/Week: 3-1-0(L–T–P)	**Credit: 4**

Course Objective:

1 To provide an understanding of environmental science by exploring its scope, importance, and the principles of sustainability and sustainable development.

2 Toanalyze ecosystems and biodiversity by studying ecological interactions, conservation strategies, and the impact of human activities on biodiversity.

3 To evaluate environmental challenges and management strategies by examining pollution, climate change, bioremediation techniques, and waste management solutions.

Course outcomes

CO No.	**Course Outcome (CO)**	
CO1	**Recall fundamental concepts of environmental science, including sustainability, ecosystems, and biodiversity.**	**K1**
CO2	**Explain ecosystem structures, functions, and ecological interactions with case studies on various ecosystems.**	**K2**
CO3	**Apply knowledge of biodiversity conservation strategies, including in-situ and ex-situ methods, to real-world scenarios.**	**K3**

CO4	**Analyze major environmental issues such as pollution, climate change, and habitat destruction, and their impact on ecosystems.**	**K4**
CO5	**Evaluate the role of bioremediation techniques in managing environmental pollution and waste disposal.**	**K4**
CO6	**Assess the socio-economic and ethical implications of environmental disasters and conservation policies.**	**K4**

COURSE CONTENT :

MODULE 1:		20 hours
Scope and introduction to environmental science- environmental studies; Scope and importance; the need for environmental education. Concept of sustainability and sustainable development.		
MODULE 2:		**20 Hours**
What is an ecosystem? Structure: food chains, food webs and function of ecosystem:Energy flow in an ecosystem, nutrient cycle and ecological succession. Ecological Interactions. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)		
MODULE 3:		**20 Hours**
Biodiversity and Conservation. - Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots b. India as a mega-biodiversity nation; Endangered and endemic species of India c. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlifeconflicts, biological invasions; Conservation of biodiversity:In-situ and Ex-situ conservation of biodiversity. d. Nature reserves, tribal populations and rights (Niyamgiri-Vedanta, POSCO), and human wildlife conflicts in Indian context (Sundarban-Human-Tiger encounters). e. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.		
Module 3		**20 hours**
environmental challenges and issues: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. b. Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture c. Nuclear hazards and human health risks (Chernobyl, 3 mile Island, Daiichi- Fukushima) d. Solid waste management: Control measures of urban and industrial waste,specialreferenceto e-waste, Biomedical waste. e. Pollution Tragedies: Love canal, Bhopal Gas, Endosulfan, Minamata and Flint water		
TOTAL LECTURES		**60 Hours**

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**3**	**–**	**–**	**1**	**–**	**2**	**2**	**3**	**2**	**3**	**3**

CO2	**3**	**2**	**2**	**2**	**3**	**–**	**–**	**2**	**–**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**–**	**–**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**–**	**–**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**–**	**–**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**2**	**2**	**2**	**3**	**–**	**1**	**3**	**2**	**3**	**3**	**3**	**3**	**3**

Developmental Biology lab (TIU-UBT-MI-L42302)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8thsem**
Course Title: Developmental Biology lab	**Subject Code**TIU-UBT-MI-L42302
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1. To understand early embryonic development by observing and analyzing developmental stages in model organisms such as sea urchins, chicks, and Drosophila melanogaster.
2. To explore plant development and tissue culture techniques by studying germination, seedling growth, and induction of plant tissue cultures.
3. To develop practical microscopy skills for examining embryonic structures and understanding morphological changes during development.

Course outcomes

CO Number	**Course Outcome**	
CO1	Identify and describe key stages of early embryonic development in sea urchins and chicks.	**K1**
CO2	Explain morphological variations and genetic traits in *Drosophila melanogaster* through observational studies.	**K2**
CO3	Demonstrate plant development processes such as germination, seedling growth, and tissue culture techniques.	**K3**
CO4	Analyze microscopic structures of embryonic development across different model organisms.	**K4**
CO5	Evaluate the impact of experimental conditions on embryonic and plant development.	**K4**
CO6	Perform laboratory techniques for embryonic observation, tissue culture, and microscopy with accuracy and precision.	**K3**

COURSE CONTENT :

Experiment 1: Observation of Early Embryonic Development in Sea	**TOTAL 60**

Urchins	**HOURS**
Experiment 2: Chick Embryo Development	
Experiment 3: Morphological Studies on Drosophila Melanogaster	
Experiment 4: Plant Development: Germination and Seedling Growth	
Experiment 5: Induction of Plant Tissue Culture	
Experiment 6: Microscopic Examination of Embryonic Development	

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**–**	**–**	**1**	**–**	**2**	**2**	**2**	**2**	**2**	**3**
CO2	**3**	**2**	**3**	**2**	**2**	**–**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**3**
CO3	**3**	**3**	**2**	**2**	**3**	**1**	**–**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**1**	**–**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**2**	**2**	**3**	**1**	**–**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

Environmental management and bioremediation lab (TIU-UBT-MI-L42303)

Program: B. Sc. in Biotech	**Year, Semester: 4th year, 8t^{h}sem**
Course Title: Environmental management and bioremediation lab	**Subject Code**TIU-UBT-MI-L42303
Contact Hours/Week: 0-0-4 (L–T–P)	**Credit: 2**

Course Objective:

1 To develop an understanding of environmental pollution and contamination assessment techniques through hands-on experiments, including water quality analysis and soil contamination assessment.

2 To explore the role of microorganisms in bioremediation by isolating and identifying microbes from contaminated sites and studying their application in biodegradation and environmental restoration.

3 To evaluate sustainable environmental management strategies such as phytoremediation and bioremediation techniques, emphasizing their effectiveness in mitigating pollution.

Course outcomes

CO Number	**Course Outcome**	
CO1	Identify key water quality parameters and their significance in environmental monitoring.	**K1**

CO2	Explain methods for assessing soil contamination and its environmental impact.	**K2**
CO3	Demonstrate microbial isolation techniques from contaminated sites and analyze microbial diversity.	**K3**
CO4	Analyze the process of biodegradation and its role in breaking down hydrocarbons.	**K4**
CO5	Evaluate phytoremediation as a strategy for removing pollutants from soil and water.	**K4**
CO6	Perform and compare different bioremediation techniques for environmental restoration.	**K3**

COURSE CONTENT :

Experiment 1: Analysis of Water Quality Parameters	**TOTAL 60 HOURS**
Experiment 2: Soil Contamination Assessment	
Experiment 3: Microbial Isolation from Contaminated Sites	
Experiment 4: Biodegradation of Hydrocarbons	
Experiment 5: Phytoremediation Experiment	
Experiment 6: Assessment of Bioremediation Techniques	

Course Articulation Matrix

	PROGRAM OUTCOMES (PO)												**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**2**	**2**	**1**	**2**	**3**	**1**	**1**	**–**	**2**	**2**	**2**	**2**	**2**	**2**
CO2	**3**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO6	**3**	**3**	**3**	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**