COURSE SCHEME AND SYLLABUS

FOR

B.Tech. (Biotechnology)

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

2023

SEMESTER-I

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UPH013	Physics	BSC	3	1	2	4.5
2.	UES101	Engineering Drawing	ESC	2	4	0	4.0
3.	UHU003	Professional Communication	HSS	2	0	2	3.0
4.	UBT008	Cell Biology and Genetics	BSC	3	0	0	3.0
5.	UMA005 UMA010	Introductory Mathematics-I (for NEET students) OR Mathematics-I (for JEE students)	BSC	3	1	0	3.5
		TOTAL		**13**	**6**	**4**	**18.0**

SEMESTER-II

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCB009	Chemistry	BSC	3	0	2	4.0
2.	UES103	Programming for Problem Solving	ESC	3	0	2	4.0
3.	UBT009	Biochemistry-I	PCC	3	0	0	3.0
4.	UEN008	Energy and Environment	BSC	2	0	0	2.0
5.	UMA006 UMA004	Introductory Mathematics-II (for NEET students) OR Mathematics-II (for JEE students)	BSC	3	1	0	3.5
6.	UBT202	Microbiology	PCC	3	0	0	3.0
7.	UBT203	Biochemistry and Microbiology Lab	PCC	0	0	4	2.0
		TOTAL		**17**	**1**	**8**	**21.5**

SEMESTER-III

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UCH301	Material and Energy Balances	ESC	3	1	0	3.5
2.	UBT308	Food Science and Nutrition	PCC	3	0	0	3.0
3.	UBT309	Immunotechnology	PCC	3	0	0	3.0
4.	UBT310	Biochemistry-II	PCC	3	0	0	3.0
5.	UBT307	Molecular Biology	PCC	3	0	0	3.0
6.	UPH012	Biophysics and Biomaterials	BSC	3	0	0	3.0
7.	UTD002	Employability Development Skills	HSS	2	0	0	2.0
8.	UBT311	Molecular Biology, Food Science and Immunology Lab	PCC	0	0	4	2.0
		TOTAL		**20**	**1**	**4**	**22.5**

SEMESTER-IV

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UBT406	Bioanalytical Techniques	PCC	3	0	0	3.0
2.	UBT408	Genetic & Metabolic Engineering	PCC	3	0	0	3.0
3.	UBT409	Animal Biotechnology	PCC	3	0	0	3.0
4.	UBT410	Plant Biotechnology	PCC	3	0	0	3.0
5.	UTA027	Artificial Intelligence	ESC	3	0	2	4.0
6.	UHU050	Evolutionary Psychology (1 Self Effort Hour)	HSS	1#	0	0	1.0
7.	UBT411	Animal and Plant Biotechnology Lab	PCC	0	0	4	2.0
		TOTAL		**15+1#**	**0**	**6**	**19.0**

SEMESTER-V

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UBT515	Biostatistics	BSC	2	0	0	2.0
2.	UBT516	Bioinformatics	PCC	3	0	0	3.0
3.	UBT517	Bioprocess Engineering	PCC	3	1	0	3.5
4.	UBT407	Transducers and Biosensors	PCC	3	0	2	4.0
5.	UTA025	Innovation and Entrepreneurship	HSS	1	0	2#	3.0
6.		Generic Elective	OEC	2	0	0	2.0
7.		Professional Elective-I	PEC	3	0	0	3.0
8.	UBT518	Biostatistics and OMICS Lab	PCC	0	0	3	1.5
		TOTAL		**17**	**1**	**7**	**22.0**

SEMESTER-VI

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UHU005	Humanities for Engineers	HSS	2	0	2	3.0
2.	UBT618	Downstream Processing	PCC	3	0	0	3.0
3.	UBT619	Pharmaceutical Technology	PCC	3	0	0	3.0
5.	UBT614	Biosafety, Bioethics & IPR	HSS	2	0	0	2.0
6.	UBT891	Capstone Project (Starts)	PRJ	1#	0	2	0.0
7.		Professional Elective-II	PEC	3	0	0	3.0
8.	UBT615	Journal Club	PRJ	0	0	0	2.0
9.	UBT620	Process Lab	PCC	0	0	4	2.0
		TOTAL		**14**	**0**	**8**	**18.0**

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

SEMESTER-VII

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UBT796	Project Semester	PRJ	0	0	0	15.0
Or							
1.	UBT705	Genomics and Proteomics	PCC	3	1	0	3.5
2.	UBT706	Enzyme Technology	PCC	3	1	0	3.5
3.	UBT797	Project	PRJ	0	0	0	8.0
Or							
1.	UBT798	Start up Semester*	PRJ	0	0	0	15.0
		TOTAL		**0**	**0**	**0**	**15.0**

SEMESTER-VIII

S. No.	Course Code	Course Name	CODE**	L	T	P	Cr
1.	UBT802	Nanobiotechnology	PCC	3	1	0	3.5
2.	UBT832	Concepts in Biomedical Instrumentation	ESC	3	0	2	4.0
3.	UBT610	Industrial Biotechnology	PCC	3	0	0	3.0
4.		Professional Elective-III	PEC	3	0	0	3.0
5.		Professional Elective-IV	PEC	3	0	0	3.0
6.	UBT891	Capstone Project	PRJ	1#	0	2	8.0
		TOTAL		**16**	**1**	**4**	**24.5**

Semester	EL Activity**
I	ELC Activity I
II	ELC Activity II
III	ELC Activity III
IV	ELC Activity IV
V	ELC Activity V

PROFESSIONAL ELECTIVE-I

S. No.	Course Code	Course Name	L	T	P	Cr
1.	UBT512	Structural Biology	3	0	0	3.0
2.	UBT513	Cell and Tissue Engineering	3	0	0	3.0
3.	UBT514	Natural Products	3	0	0	3.0

PROFESSIONAL ELECTIVE-II

S. No.	Course Code	Course Name	L	T	P	Cr
1.	UBT502	Food Processing	3	0	0	3.0
2.	UBT624	Medical Biotechnology	3	0	0	3.0
3.	UBT616	Protein Engineering	3	0	0	3.0

PROFESSIONAL ELECTIVE-III

S. No.	Course Code	Course Name	L	T	P	Cr
1.	UBT837	Cancer Biology	3	0	0	3.0
2.	UBT838	Stem Cell Technology	3	0	0	3.0
3.	UBT839	Drug Design and Development	3	0	0	3.0

PROFESSIONAL ELECTIVE-IV

S. No.	Course Code	Course Name	L	T	P	Cr
1.	UBT844	Environmental Biotechnology	3	0	0	3.0
2.	UBT845	Molecular Diagnostics	3	0	0	3.0
3.	UBT846	Computational Biology	3	0	0	3.0

GENERIC ELECTIVE

S. No.	Course Code	Course Name	L	T	P	Cr
1.	UHU016	Introductory Course in French	2	0	0	2.0
2.	UCS002	Introduction to Cyber Security	2	0	0	2.0
3.	UHU017	Introduction to Cognitive Science	2	0	0	2.0
4.	UHU018	Introduction to Corporate Finance	2	0	0	2.0
5.	UEN006	Technologies for Sustainable Development	2	0	0	2.0
6.	UPH064	Nano Science and Nano-Materials	2	0	0	2.0
7.	UMA069	Graph Theory and Applications	2	0	0	2.0
8.	UMA070	Advanced Numerical Methods	2	0	0	2.0
9.	UBT510	Biology for Engineers	2	0	0	2.0

Nature of course and code

Nature of the course	CODE**
Basic Science Courses	BSC
Engineering Science Courses	ESC
Humanities and Social Science Courses	HSS
Professional Core Courses	PCC
Open Elective Courses	OEC
Project	PRJ

Total Credits: 160.5

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

Breakup of courses based on the category:

S. No.	Category	Breakup of Credits
1.	Humanities & Social Science Courses	14
2.	Basic Science Courses	25.5
3.	Engineering Science Courses	19.5
4.	Program Core Courses (Branch specific)	62.5
5.	Professional Elective Courses (Branch specific)	12
6.	Open Elective Courses (Cross Discipline Subjects)	2
7.	Project work, Seminar and Internship in Industry or elsewhere	25

SEMESTER-I

UHU003: PROFESSIONAL COMMUNICATION

L	T	P	Cr
2	0	2	3.0

Course Objective: To introduce the students to effective professional communication. The student will be exposed to effective communication strategies and different modes of communication. The student will be able to analyze his/her communication behavior and that of the others. By learning and adopting the right strategies, the student will be able to apply effective communication skills, professionally, and socially.

Syllabus

Effective communication: Meaning, Barriers, Types of communication and Essentials. Interpersonal Communication skills

Effective Spoken Communication: Understanding essentials of spoken communication, Public speaking, Discussion Techniques, Presentation strategies

Effective Professional and Technical writing: Paragraph development, Forms of writing, Abstraction and Summarization of a text; Technicalities of letter writing, internal and external organizational communication. Technical reports and proposals

Effective non-verbal communication: Knowledge and adoption of the right non verbal cues of body language, interpretation of the body language in professional context. Understanding Proxemics and other forms of non-verbal communication

Communicating for Employment: Designing Effective Job Application letter and resumes.

Communication Networks in organizations: Types, barriers and overcoming the barriers.

Laboratory Work (if applicable)

1. Needs-assessment of spoken and written communication and feedback.
2. Training for Group Discussions through simulations and role plays.
3. Technical report writing on survey-based projects.
4. Project based team presentations.

Course Learning Objectives (CLO)
The students will be able to:

1. Apply communication concepts for effective interpersonal communication.
2. Select the most appropriate media of communication for a given situation.
3. Speak assertively and effectively.

4. Write objective organizational correspondence.
5. Design effective resumes, reports and proposals.

Text Books

1. Lesikar R.V and Flately M.E., Basic Business Communication Skills for the Empowering the Internet Generation. Tata Mc Graw Hill. New Delhi (2006).
2. Raman, M & Sharma, S., Technical Communication Principles and Practice, Oxford University Press New Delhi. (2011).
3. Mukherjee H.S., Business Communication – Connecting at Work, Oxford University Press New Delhi, (2013).

Reference Books

1. Butterfield, Jeff., Soft Skills for everyone, Cengage Learning New Delhi, (2013).
2. Robbins, S.P., & Hunsaker, P.L., Training in Interpersonal Skills, Prentice Hall of India, New Delhi, (2008).
3. DiSianza, J.J. & Legge, N.J., Business and Professional Communication, Pearson Education India New Delhi, (2009).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (Group discussions; professional presentations; poster presentations, public speaking; technical reports)	30

UBT008: CELL BIOLOGY AND GENETICS

L	T	P	Cr
3	0	0	3.0

Course Objective: The course is aimed to impart knowledge of structural and functional aspects of cells as unit of living systems. To understand functions of various organelles and transport of information and matter across cell membrane and classical genetics comprising Mendelian laws of inheritance and their significance in genetic diseases.

Syllabus

Cell structure and function: Cell – structural and functional unit of life, cell morphology, difference between bacterial, plant and animal cells, structure and function of cellular organelles, plasma membrane and cell wall, cytoskeleton, transport across cell membrane.

Cell division: Mitosis and meiosis, cell cycle and its regulation, apoptosis and necrosis.

Genetics: Mendel's laws of inheritance, Intra-allelic and inter-allelic interaction, incomplete dominance, codominance and blood types, Multiple alleles, Lethal genes, Polygenic inheritance, cytoplasmic inheritance, chromosomal structure, nucleosome and chromatin, sex determination and sex-linked inheritance.

Linkage and recombination: Recombination and crossing over, linkage maps, mapping of genes, Hardy-Weinberg distribution.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Acquire knowledge about the organizational and functional aspects of cell and organelles.
2. Learn about the interactions of the cells with outside environment through exchange of information and transport of molecules.
3. Learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics.
4. Develop innovative research ideas for curing genetic disorders in humans.

Text Books

1. Bruce Alberts et al., Essential cell biology, Garland Science (Taylor & Francis Group).
2. Gardner, Simmons and Snustad, Principles of Genetics by John Wiley & Sons.
3. Veer Bala Rastogi, Cell Biology (MedTech Science Press).
4. Eddon John Gardner. Principles of Genetics (Wiley; 8th edition).

Reference Books

1. H Lodish et al., Molecular Cell Biology (4th edition), WH Freeman.
2. MW Stickberger, Genetics (3rd edition), PHI Learning Pvt Ltd (2012).
3. Geoffrey M. Cooper., The Cell: A Molecular Approach (Sinauer Associates Inc).
4. Peter J. Russel. *i*Genetics: A Molecular Approach (Pearson Education India).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UMA010: MATHEMATICS-I

L	T	P	Cr
3	1	0	3.5

Course Objective: To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

Syllabus

Partial Differentiation: Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives.

Multiple Integrals: Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, evaluation of triple integral (Cartesian).

Sequences and Series: Introduction to sequences and Infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence and conditional convergence.

Series Expansions: Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration.

Complex analysis: Introduction to complex numbers, geometrical interpretation, functions of complex variables, examples of elementary functions like exponential, trigonometric and hyperbolic functions, elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy-Riemann equations, analytic functions, harmonic functions.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Examine functions of several variables, define and compute partial derivatives, directional derivatives and their use in finding maxima and minima in some engineering problems.
2. Evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
3. Determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.

4. Represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy-Riemann equations.

Text Books

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.
2. Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.
3. Kasana, H.S., Complex Variables: Theory and Applications, Prentice Hall India, 2005 (2nd edition).

Reference Books

1. Wider David V, Advanced Calculus: Early Transcendentals, Cengage Learning (2007).
2. Apostol Tom M, Calculus, Vol I and II, John Wiley (2003).
3. Brown J.W and Chruchill R.V, Complex variables and applications, McGraw Hill, (7th edition)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/tutorials/quizzes)	30

UMA005: INTRODUCTORY MATHEMATICS-I

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective is to develop the basics of computing skills and application of quantitative and statistical operations required for biological studies.

Syllabus

Algebra: Complex numbers, Solution of quadratic equations, Permutations and combinations, Binomial theorem for positive/negative index and its simple applications, Arithmetic and geometric progression

Trigonometry: Review of trigonometric functions, Sum and product formulae for trigonometric functions, Trigonometric equations and sum - to - product formulae for trigonometric functions, Identities related to double angle formulae

Determinants and Matrices: Matrices, Operations on matrices, Determinants and its properties, Singular and non-singular matrices, Adjoint and inverse of a matrix and its properties, Solution of system of linear equations using Cramer's rule and matrix method

Coordinate Geometry: Rectangular coordinate system, Straight lines, Circles (in standard form only)

Statistics: Measure of dispersion: mean deviation, Variance and standard deviation of grouped/ungrouped data. Correlation and regression

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. acquire knowledge of basic algebra, trigonometry, matrices, coordinate geometry etc.
2. apply these concepts to solve complex mathematical problems
3. analyse the data of any experiment statistically to extract meaningful result
4. tackle any mathematical challenge that usually occurs during their biological studies.

Text Books

1. Mathematics, A Text books (Parts I & II), NCERT, New Delhi (2011).
2. Kreyszig, Erwin, Advanced Engineering Mathematics, John Wiley, (1999).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

Reference Books

1. Krishnamurthy V.K., Mainra V.P. and Arora J.L. An introduction to Linear Algebra, Associated East West Press (2007).
2. Loney, S. L., The elements of Coordinate Geometry, Michigan Historical Reprint series, (2012)
3. Meyer, P. L., Introductory Probability and Statistical Applications, Addison Wesley (1970).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/tutorials/quizzes)	30

SEMESTER-II

UBT009: BIOCHEMISTRY-I

L	T	P	Cr
3	0	0	3.0

Course Objective: The students will know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving thing.

Syllabus

Biochemistry: Introduction as a discipline-historical perspective, major landmarks in the development of biochemistry.

Chemical Foundations of living systems: Molecular basis of life, Biological chemistry – Biomolecules, Metabolism – Basic concepts and Design, Bioenergetics- Entropy, Biochemical equilibria, Dissociation and association constants, pH and buffers.

Interactions in biological systems: Intra and intermolecular forces, Electrostatic and hydrogen bonds, Disulfide bridges, Hydrophobic and hydrophilic molecules and forces, Water and weak interactions, Debye-Huckel Theory.

Carbohydrates: Classification, Monosaccharides – structures and function; reactions of monosaccharides- mutarotation, glycoside formation, reduction and oxidation, epimerization and esterification, polarimetry; important monosaccharides and disaccharide; Polysaccharides –overview, structure; important polysaccharide; plant polysaccharide; Glycosaminoglycans, Glycoproteins.

Amino acids and Proteins: Amino acids as building blocks of proteins, their structure, classification and chemical properties; non- proteinogenicaminoacids; Structure of peptide bond, organizational levels of protein structure; alpha- helix, beta pleated sheet, Ramachandran Plot.

Nucleic Acids and Porphyrins: Structure and properties of nucleic acid bases, nucleosides and nucleotides, biologically important nucleotides, Physical and chemical properties of RNA/DNA. Hydrolysis of nucleic acids. Structure, properties and classification of porphyrins.

Lipids: Fatty acids as building blocks of most lipids, their structure and properties, classification of lipids, General structure and function of major lipid subclasses: Acylglycerols, phosphoglycerides, sphingolipids, glycosphingolipids, terpenes, steroids, Prostaglandins.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Know the chemical constituents of cells, the basic units of living organisms.
2. Explain various types of weak interactions between the biomolecules.
3. Know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.
4. Correlate the structure-function relationship in various biomolecules
5. Know the role of biomolecules for orderly structures of the cells/tissues.

Text Books

1. Nelson, DL and Cox MM., Lehninger: Principles of Biochemistry, WH Freeman (2008) 5th ed.
2. David E Metzler: Biochemistry, The Chemical reactions of Living Cells Vol. 1. 2nd Edition, Elsevier Academic Press (2003),
3. Berg JM, Tymoczko JL and Stryer L: Biochemistry, 5th Edition, WH Freeman and Company, (2005)

Reference Books

1. Koolman J and Roehm K H Color: Atlas of Biochemistry, 2nd Edition, Georg Thieme Verlag Publishers (2005)
2. Jain, JL, Jain, S and Jain, N: Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).
3. Plummer DT: An Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Company Limited (1988)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UEN008: ENERGY AND ENVIRONMENT

L	T	P	Cr
2	0	0	2.0

Course Objective: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the value of regional and global natural and energy resources; and emphasize on need for conservation of energy and environment.

Syllabus

Introduction: Natural Resources & amp; its types, Concept of sustainability and sustainable use of natural resources, Pollution based environmental issues and case-studies.

Conventions on Climate Change: Origin of Conference of Parties (COPs), United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC); Kyoto Protocol, instruments of protocol – CDM, JI and IET; Montreal Action Plan; Paris Agreement and post-Paris scenario.

Air Pollution: Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; Wind roses; Atmospheric Stability; Inversion; Plume behavior; Management of air pollution: Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary and mobile sources.

Water Pollution: Origin, Sources of water pollution, Category of water pollutants, Physico-Chemical characteristics, Components of wastewater treatment systems, Advanced treatment technologies.

Solid Waste Management: Introduction to solid waste management, Sources, characteristics of municipal and industrial solid waste, Solid waste management methods: Incineration, composting, Biomethanation, landfill, E-waste management, Basal convention.

Energy Resources: Classification of Energy Resources; Conventional energy, resources-Coal, petroleum and natural gas, nuclear energy, hydroelectric power; Non-conventional energy resources – Biomass energy, Thermo-chemical conversion and biochemical conversion route; Generation of Biogas and biodiesel as fuels; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications; Wind energy.

Facilitated through Online Platforms:

Ecology and Environment: Concept of an ecosystem; structural and functional units of an ecosystem; Food Chain, Food Web, Trophic Structures and Pyramids; Energy flow; Ecological Succession; Types, Characteristics, Biodiversity, Biopiracy.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

Human Population and the Environment: Population growth, variation among nations; Population explosion – Family Welfare Programmes; Environment and human health; Human Rights; Value Education; Women and Child Welfare; Role of Information Technology in Environment and Human Health, Environmental Ethics.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend the interdisciplinary context with reference to the environmental issues and case studies.
2. Assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.
3. Conceptualize and explain the structural and functional features of ecological systems.
4. Correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies.

Text Books

1. Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)
2. Down to Earth, Environment Reader for Universities, CSE Publication (2018)
3. Chapman, J.L. and Reiss, M.J., Ecology - Principles and Application, Cambridge University Press (LPE) (1999).
4. Eastop, T.P. and Croft, D.R., Energy Efficiency for Engineers and Technologists, Longman and Harow (2006).
5. O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).
6. Peavy H.S. and Rowe D.R. Environmental Engineering, McGraw Hill (2013).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals/Quizzes/Projects Evaluations	30

UMA006: INTRODUCTORY MATHEMATICS-II

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective is to develop basic computing skills and application of quantitative required for biological studies and rationalization of experimental designs.

Syllabus

Differentiation: Functions, Domain and range, Properties of standard functions (trigonometric, exponential and logarithmic) and their graphs, Limit, Continuity and Differentiability. Differentiation of standard functions (polynomials, trigonometric, inverse trigonometric exponentials and logarithmic), Product rule, Quotient rule, Chain rule, Applications of derivatives in graphing, Maximum and minimum of single variable function, Functions of several variables, Partial derivatives, Homogeneous functions, Maximum and minimum of several variable functions.

Integration: Integral as anti-derivative, Integration: by substitution, by parts and partial fractions, Definite integral and its properties, Double integrals, Areas of bounded regions and rectification.

Differential Equations: Order and degree, General and particular solution of differential equation, Techniques for solving first order ordinary differential equation and its applications to biological problems (population growth, radioactive decay).

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain functions, related properties and determine their continuity and differentiability.
2. Apply derivatives in graphing and maxima and minima of single variable function.
3. Predict integration of function using by parts, by substitution and partial fraction methods and apply these to find areas of bounded regions and rectifications.
4. Learn methods to solve first order ordinary differential equations and apply it to biological problems.

Text Books

1. Mathematics, A Text books (Parts I & II), NCERT, New Delhi, 2011.
2. Thomas, G.B. and Finney, R.L. Calculus and Analytical Geometry, Pearson Education, 10th ed., 2007.

Reference Books

1. Kreyszig, Erwin, Advanced Engineering Mathematics, 8th Edition, John Wiley, 1999.
2. Shanti Narayan, Differential and Integral Calculus, S. Chand, 2005.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/tutorials/quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UMA004: MATHEMATICS-II

L	T	P	Cr
3	1	0	3.5

Course Objective: To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.

Syllabus

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.

Fourier Series: Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Solve the differential equations of first and second order and basic application problems described by these equations.
2. Find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.
3. Find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.
4. Solve systems of linear equations by using elementary row operations.
5. Identify the vector spaces/subspaces and to compute their bases / orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the Eigen values and Eigen vectors.

Text Books

1. Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).
2. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

Reference Books

1. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006), 8th ed.
2. Jain, R.K. and Iyenger, S.R.K., Advanced Engineering Mathematics, Narosa Publishing House (2011), 11th ed.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/tutorials/quizzes)	30

UBT202: MICROBIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide fundamental understanding of the microbial world, basic structure and functions of microbes, metabolism, nutrition, their diversity, physiology and relationship to environment and human health. To impart practical skills of isolation and manipulating conditions for their propagation.

Syllabus

History and classification: Brief history on development and scope of microbiology, characterization, classification and identification of microorganisms, numerical taxonomy and molecular approaches, microscopic examination of microorganisms, bacterial staining, simple and differential staining

Morphology and fine structure of microorganisms: Prokaryotes and eukaryotes, bacterial diversity, bacterial cell structures, Gram positive and Gram-negative bacteria, morphological features, cell structure and major characteristics of cellular (bacteria, fungi, algae, protozoa) and acellular (viruses) organisms

Cultivation and cultural characterization of microorganisms: Nutritional and physical requirements of autotrophs, heterotrophs, chemotrophs and lithotrophs, types of culture media, enumeration of microbial populations, pure culture and cultural characteristics
Microbial Growth: Modes of cell division, normal growth cycle, and quantitative measurement of growth, growth curve, synchronous growth and continuous culture, factors affecting growth, sporulation, Maintenance and preservation of microbial cultures and its importance, culture banks

Microbial Physiology: Bacterial metabolism, energy production, respiration, intermediate metabolism, fermentation and photosynthesis

Microorganisms and Diseases: Major diseases caused by different microorganism in human, animals and plants

Microbial Control: Physical and chemical agents for control of microbial growth, their mode of action, sterilization, disinfectants and antiseptics, chemotherapeutic agents, antibiotic susceptibility test

Course Learning Objectives (CLO)
The students will be able to:

1. Define the science of microbiology, its development and importance in human welfare.

2. Describe historical concept of spontaneous generation and the experiments performed to disprove.
3. Describe some of the general methods used in the study of microorganisms.
4. Recognize and compare structure and function of microbes and factors affecting microbial growth.
5. Demonstrate aseptic microbiological techniques in the laboratory and check sources of microbial contamination and their control.

Text Books

1. Pelczar Jr., M.J., Chan, E.C.S. and Krieg, Noel R., Microbiology, Shree Hari Publications (2021).
2. Stanier, R.Y., Ingraham, J.L. and Wheelis, M.L., General Microbiology, MacMillan (2007) 5th ed.
3. Madigan, M. T. and Martinko, J. M., Brock Biology of Microorganisms, Pearson Publication (2017) 14th ed.

Reference Books

1. Tortora, G.J., Funke, B.R., and Case, C.L., Microbiology: An Introduction, Pearson Education
(2019) 4th ed.
2. Willey, J. and Sherwood, L., Prescott's Microbiology, Asia Higher Education Science Microbiology (2017)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT203: BIOCHEMISTRY AND MICROBIOLOGY LAB

L	T	P	Cr
0	0	4	2.0

Course objective: To provide provide fundamental understanding of protocols in basic biochemistry and microbiology with learning technique like TLC, UV-visible spectroscopy and microscopy. The course has an industrial reference as they form part and parcel of various SOPs related to microbiology and biochemical analysis.

Detail contents:

Microbiology:

Light Microscopy, microscopic examination of different microbes; Gram staining, spore staining; Preparation of culture media and sterilization techniques; sources of microbial contamination, isolation of heterotrophs and autotrophs; enumeration of microbial population in soil and water; microscopic measurement of cell dimension and growth by cell counting, growth measurement and growth curve.

Biochemistry:

Preparation of Buffers (Acidic/Basic/Neutral); Qualitative test for Carbohydrates, Fats, Proteins and Amino Acids (includes TLC separation also); Quantitively estimate sugars by preparation of Standard curve of D-Glucose by DNSA method (includes principles of UV-Visible spectrophotometry); Standard curve of Protein by Folin Lowry's Method (including estimation of unknown), Determination of acid and saponification value of fats, Determination of optimal conditions (temperature, pH, Substrate concentration) for optimal activity of amylase enzyme, Separation and estimation of photosynthetic pigments (chl a & chl b) from spinach leaves (TLC/Spectrophotometric determination)

Course Learning Outcomes (CLO):

Students will be able to

1. analyze and distinguish different biomolecules which play a crucial role in process of life
2. analyze, compose and effectively communicate the observations and results of scientific investigation in a standard format.
3. describe some of the general methods used in the study of microorganisms.
4. demonstrate aseptic microbiological techniques in the laboratory and check sources of microbial contamination and their control.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

Text books

1. K. Wilson and J. Walker (ed.), Practical Biochemistry, Principles and Techniques, Cambridge University Press, 1995
2. S.K. Sawhney and Randhir Singh (ed.) Introduction Practical Biochemistry, Narosa Publishing House, 2009
3. Pelczar Jr., M.J., Chan, E.C.S. and Krieg, Noel R., Microbiology, McGraw Hill (2003) 5th ed.
4. Microbiology- a Laboratory Manual, 2nd Ed, JG Cappuccino and N Sherman, Benjamin/Cummings Publ. Company, Inc. 1987.

Reference Books

1. R. Boyer, Modern Experimental Biochemistry, 3rd Ed., Pearson Education (Singapore) Pvt. Ltd., 2001
2. R. L. Switzer and L. F. Garrity, Experimental Biochemistry, 3rd Ed., W. H. Freeman, 1999
3. Tortora, G.J., Funke, B.R., and Case, C.L., Microbiology- An Introduction, Pearson Education (2007)8th ed.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Sessionals (May include assignments / quizzes / performance)	100

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UCH301: MATERIAL AND ENERGY BALANCES

L	T	P	Cr
3	1	0	3.5

Course Objective: To understand and apply the basics of calculations related to material and energy flow in the processes.

Syllabus:

Introduction: Units and dimensions, Stoichiometry of chemical equations, Mole and weight fractions, Unit operations and unit processes with reference to material and energy balance calculations

Behaviour of Gas and Liquid Mixtures: Gas laws, Raoult's law, Henry's law, Duhring's plot, Saturation, Partial saturation, Relative saturation, Real gases, Bubble point and dew point temperatures

Material Balance Calculations: Law of conservation of mass, General material balance equation, Material balance calculations without chemical reactions, Material balance calculations with chemical reactions, Recycling, Bypass, Purge, Analysis of degrees of freedom

Energy Balance Calculations: General energy balance equation, Internal energy, Enthalpy, Heat capacity of gases, liquids, and solids, Latent heats, Heats of formation, combustion, reaction and dissolution, Enthalpy-concentration chart, Fuel heating value, Theoretical flame temperature, Energy balance calculations in unit operations and systems with and without chemical reactions, Humidity and psychrometric chart, Energy balance calculations in humidification and adiabatic cooling

Laboratory Work (if applicable)

Sample List of Micro-Projects
Students in a group of 4/5 members will be assigned a micro project.
1. Complete material balances on a process flow sheet
2. Energy balances on a complete process flow sheet
3. Analyze the degrees of freedom for a complete process

Course Learning Objectives (CLO)
The students will be able to:

1. Predict the behaviour of gas and liquid mixtures.
2. Make material balances on unit operations and processes.
3. Perform simultaneous material and energy balances with and without chemical reactions.

4. Evaluate the degrees of freedom for a system.
5. Solve practical problems related to humidification/dehumidification and saturation.

Text Books

1. Himmelblau, D.M. and Riggs, J.B., Basic Principles and Calculations in Chemical Engineering, Prentice Hall of India (2003).
2. Bhatt, B.I. and Vora, S.M., Stoichiometry, Tata McGraw Hill (2004).

Reference Books

1. Hougen, O.A., Watson, K.M. and Ragatz, R.A., Chemical Process Principles, Volume-I, C.B.S. Publications (2004).
2. Felder, R.M, and Rousseau, R.W., Elementary Principles of Chemical Processes, C.B.S. Publications (2000).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/tutorials/quizzes)	30

UBT308: FOOD SCIENCE AND NUTRITION

L	T	P	Cr
3	0	0	3.0

Course Objective: To impart knowledge about the various areas related to food science as a discipline. To develop an understanding of food composition, food quality, analysis and food laws.

Syllabus

Food composition: Introduction to food science as a discipline, Constituents of food (macronutrients and micro-nutrients), functional properties, food sources and deficiency diseases. Other food constituents: Bioactive compounds, anti-nutritional factors, pigments.

Food and nutrition: Malnutrition, recommended dietary allowances (RDAs) for various age groups, the concept of a balanced diet, diet planning. Special dietary needs of people with different medical conditions. Food groups and their classification.

Food microbiology: Food spoilage by micro-organisms: classification of foods on the basis of spoilage, factors affecting the growth of microorganisms in food, chemical changes caused by microorganisms. Foodborne illness (infection and intoxication), pathogenic micro-organisms in food. Desirable relationship of microorganisms with food (fermentation, probiotics).

Food quality and laws and Standards: Food quality & analysis: Quality factors in food physical, chemical and microbiological factors of quality. Sensory evaluation of foods. Sample and sample preparation in foods, proximate analysis of foods. Food laws: voluntary and mandatory food laws in India.

Impetus in Food Industry: New Product Development, strategies, planning for marketing, Process designing of food. Foods types available in the market and need of their innovation.

Course Learning Objectives (CLO)

The students will be able to:

1. Explain importance of different types of nutrients in balanced diet and diet planning.
2. Differentiate between different nutrient components in food and their role in processing and consumption.
3. Correlate basic food microbiology with food safety laws and standards.
4. Determine food quality by food analysis as per food laws and their importance in food industry.
5. Apply traditional methods for food preservation in developing a new food product.

Text Books

1. Vaclavik, Vickie, Christian, Elizabeth W - Essentials of Food Science 4th Ed. (2014).
2. Geoffrey Campbell-Platt - Food Science and Technology, Wiley-Blackwell Publisher. 2nd Ed. (2017).
3. Sunetra Roday- Food Science and Nutrition, 2nd Edition, Publisher-Oxford (2012).
4. B. Srilakshmi Food Science, 5th ed. New Age Publishers (2010).
5. L.H. Meyer Food Chemistry, New Age Publishers (2004).
6. Frazier C and Westhoff, C. Food Microbiology, TMH, New Delhi. 5th Ed (2017).

Reference Books

1. S. Suzanne Nielsen-Food Analysis: Food Science Texts Series, Springer; 4th Edition (2010).
2. Avantina Sharma Textbook of Food Science & Technology (Vol - I & II), International Book Distributing Company, 2nd ed. (2010).
3. Fennema's Food Chemistry, 5th Edition (Food Science and Technology, CRC Press; 4 edition (2017).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT309: IMMUNOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide students with detail understanding of basic concepts of immune system, application of immunological techniques, immune dysregulation in health disorder.

Syllabus

Basic concept and cells of the Immune System: Hematopoietic stem cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in innate and adaptive Immunity, MHC, Inflammatory response, Complement System

Antigens and Antibodies: Antigenicity and Immunogenicity Epitopes, Adjuvants, Superantigens, Antigen Presentation and processing, Structure and function of antibody, Antibody classes, Passive antibody therapy, Monoclonal antibody, Antibody engineering, Generation of antibody diversity

Immunological Techniques: Cross reactivity, Precipitation and Agglutination reaction, Coomb's test, RIA, ELISA, ELISPOT assay, Western blotting, Immunofluorescence and Flow cytometry

Immunological disorder: Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

Vaccine and Immunotherapy: Criteria for effective vaccine, Live and Killed Vaccines, Subunit vaccines, Recombinant Vaccines, DNA vaccines, mRNA vaccines, Peptide vaccines

Course Learning Objectives (CLO)

The students will be able to:

1. Explain the role of immune cells and their mechanism in body defense mechanism.
2. Adopt immunological techniques for industrial uses.
3. Demonstrate the association of immune system with different health ailments.
4. Apply the immunological concept in developing vaccine.

Text Books

1. Punt J, Stranford S, Jones P, Owen J. Kuby- Immunology W.H. Freeman & Company (2019) VIIIth edition.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

2. Murphy K., and Weaver C. Janeway Immunobiology Garland Exclusive (2016) IXth edition.

Reference Books

1. Delves P. J., Martin S. J., Burton D. R., Roitt I. M. Roitt's Essential Immunology Wiley Publisher (2017) 8th Edition.
2. Khan F.H. The Elements of Immunology, Pearson Education (2009).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessionals (May include Assignments/Quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT310: BIOCHEMISTRY-II

L	T	P	Cr
3	0	0	3.0

Course Objective: To make Students understand interaction of biomolecules in cell, biotransformations and enzyme-catalyzed metabolic pathways obeying physical and chemical laws to maintain and perpetuate life forms.

Syllabus

Bioenergetics: Basic principles of thermodynamics, Common biochemical reactions, Concepts of energy and energy change in biochemical processes, Factors affecting free energy changes in biochemical reactions, Group transfer potential, Role of ATP as energy currency, High energy phosphates and thioesters in biological systems, Biological oxidation-reduction reactions

Enzymes: Nomenclature of enzymes, Enzyme kinetics, Mechanism of enzymatic, Catalysis, Active site, Activators and inhibitors, Coenzymes, Isoenzymes, Michaelis-Menten equation, Km and Vmax value, Regulation of enzyme activity (single-substrate and multi-substrate reactions)

Intermediary Metabolism: Basic concept and design of metabolism, Regulation of metabolic pathways, Basic carbohydrate metabolism: glycolysis, TCA cycle, pentose phosphate pathway, gluconeogenesis, and glycogen metabolism; Electron transport and oxidative phosphorylation; Photosynthesis; Fatty acid and lipid metabolism; Metabolism of amino acids, purines, pyrimidines and nucleotides

Biosignaling: General features of signal transduction, G protein-coupled receptors, and second messengers, Receptor Tyrosine kinases, Gated ion channels, signaling by steroid hormones, Cell cycle, Regulation of cell cycle by protein kinases, programmed cell death

Integration of Metabolic Pathways: Hormonal control, inter-relationships between carbohydrate, protein, lipid and nucleic acid metabolism

Course Learning Objectives (CLO)
The students will be able to:

1. Know the various signals that influence different cellular/metabolic processes.
2. Realize that all the cellular/biochemical changes obey the basic thermodynamic principles.
3. Explain release of free energy during catabolic breakdown of the substances and its utilization during anabolic pathways.
4. Comprehend role of hormones in the integration of metabolic pathways.
5. Perform various experiments related to biochemistry.
6. Comprehend role of enzymes as biocatalysts and mechanisms of enzyme catalysis.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

Text Books

1. Nelson, D.L. and Cox, M.M., Lehninger Principles of Biochemistry, W.H. Freeman (2008) 5th ed.
2. Jain, J.L., Jain, S. and Jain, N., Fundamentals of Biochemistry, S. Chand and Company Ltd. (2005).
3. Rao, B.S. and Deshpande, V., Experimental Biochemistry: A Students companion. Anshan Publication (2005).
4. Wilson, K. and Walker, J., Practical Biochemistry, Principles and Techniques, Cambridge University Press (1995) 5th ed.

Reference Books

1. Berg, J.M., Tymoczko, J.L. and Stryer, L., Biochemistry, W. H. Freeman (2006) 6th ed.
2. Campbell, M.K. and Farrell, S.O., Biochemistry, Brooks Cole (2006) 5th ed.
3. Switzer, R.L. and Garrity, L.F., Experimental Biochemistry, W. H. Freeman (1999) 3rd ed.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT307: MOLECULAR BIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To understand storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems. The course also aims to make Students understand intricate molecular mechanisms of carcinogenesis and apoptosis and their applications.

Syllabus

Storage and replication of genetic information: chromosomal structure and organization, nucleic acids, Transfer of genetic material in microorganisms - Molecular mechanisms. DNA replication in phages, prokaryotes and eukaryotes, origin of replication and replication machinery, DNA damage and repair systems, excision repair systems, recombination repair systems, recombination.

Transcription: Defining a gene, interrupted genes, structure and function of phage, prokaryotic and eukaryotic promoters, eukaryotic and prokaryotic transcription initiation, RNA polymerases and ancillary factors required for transcription initiation, elongation and termination. Regulation of gene expression in prokaryotes, phages and eukaryotes, epigenetic regulation of genes, regulatory RNA.

Post-transcriptional modifications and translation: RNA processing, polyadenylation, 5' capping, splicing, structure and function of rRNAs, tRNAs, prokaryotic and eukaryotic ribosomes. Genetic code, initiation, elongation and termination of translation, post-translational modifications, signal peptides and protein translocation.

Applications of molecular biology: Gene silencing by RNA interference, oncogenes, proto-oncogenes and tumour suppressor genes, apoptosis, molecular biology of genetic and metabolic disorders, aging and senescence.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain the properties of genetic materials and storage and processing of genetic information.
2. Apply mechanisms of DNA replication, damage and repair in applied molecular genetics.
3. Apply mechanisms involved in gene expression and regulation in genetic engineering.
4. Explain molecular basis of complex metabolic diseases.

Text Books

1. J. E. Krebs, E. S. Goldstein, S. T. Kilpatrick, Lewin's Genes XI, International Edition, Pearson Education (2014).
2. Malacinsk, G. M., i Freifelders Essentials Of Molecular Biology, 4Th/Ed, Jones & Bartlett (2015)
3. Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2007).

Reference Books

1. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed. ISBN 1-4051-3544-1
2. Rastogi, S. & Pathak, N., Genetic Engineering, Oxford Higher Education (2009).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UPH012: BIOPHYSICS AND BIOMATERIALS

L	T	P	Cr
3	0	0	3.0

Course Objective: This course introduces the concepts of chemical binding, stability and transport phenomenon to the students. Introduction to various biomaterials for specific biomedical applications is also given.

Syllabus

Chemical binding: Biomolecules, chemical bonding, interatomic potentials for strong and weak bonds, ionization potential, electron affinity, electronegativity, variation in properties with bonding character.

Thermodynamics and diffusion Kinetics: Free energy, internal energy, concept of equilibrium, stability and metastability, basic thermodynamic functions, statistical nature of entropy, kinetics of thermally activated process, Fick's law of diffusion, solution to Fick's second law and its applications, Kirkendall effect, atomic model of diffusion.

Biomaterials: Classification: Metals, Ceramics, polymers, Composites, Hydrogels, Bioresorbable and Biodegradable materials, Properties of biomaterials: Physical, Thermal, Electrical and Optical, Surface properties, Structure-property relationship of biological materials.

Novel Biomaterials: Hydrogels, Self-assembling peptides, Metallic implant materials (stainless steels, Co-based alloys, Ti based alloys), Ceramic implant materials (aluminum oxides, hydroxyapatite glass ceramics), Polymeric implants, polymers for drug delivery, In-vitro and in-vivo applications of biomaterials

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain various characteristics of materials based on interatomic potential plots
2. Analyse basic kinetic reactions in living systems by applying governing laws of thermodynamics.
3. Analyse the suitability of the material to be used as a biomaterial.
4. Compare the performance of different biomaterials in biomedical applications

Text Books

1. Rodney Cotterill, BIOPHYSICS An Introduction, John Wiley and Sons (2002).
2. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
3. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).
4. V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi, 2005.

Reference Books

1. J. Breme, R.Thul and C. J. Kirkpatrick, Metallic Biomaterial Interfaces Wiley (2008).
2. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).

Evaluation Scheme

Sr. No	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessionals	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT311: MOLECULAR BIOLOGY, FOOD SCIENCE AND IMMUNOLOGY LAB

L	T	P	Cr
0	0	4	2.0

Course objective: The course aims to make students understand and comprehend the basic concepts of molecular biology, food science and immunology and get hands-on experience with the basic techniques for determining food composition.

Detail contents:

Molecular Biology:

Bacterial transformation, Isolation of plasmid DNA, Genomic DNA and total RNA isolation from bacterial cells, UV spectrophotometric analysis of DNA samples, Restriction digestion and its analysis by Agarose gel electrophoresis / Native PAGE, Amplification of target DNA by PCR, Gene induction

Food Science:

Determining the RDA's and planning diet, Estimation of moisture content of foods, Extraction and estimation of fat content of foods, Determining protein content in food through Kjeldhal's method, Determine the quality of various foods (dairy, fruit and vegetable, bakery products), Sensory evaluation of foods

Immunology:

Performance of blood typing, Performance of latex agglutination, Quantification of antigen concentration using radial immunodiffusion method, Study of the reaction pattern of an antigen with a set of antibodies by Ouchterlony Double Diffusion method, Quantification of antigen concentration by Sandwich ELISA method, Isolation of peripheral blood mononuclear cells (PBMCs) from EDTA blood

Course Learning Outcomes (CLO)

The students will be able to:

1. transform bacterial cells with plamid DNA, isolate plasmid, genomic DNA and total RNA.
2. perform facile techniques of molecular biology.
3. determine food quality by food analysis.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

4. apply the immunological concept and techniques for research purposes and industrial uses.

Textbooks

1. Rangana, S. Handbook of Analysis and Quality Control For Fruit and Vegetable Products.
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
3. Punt J, Stranford S, Jones P, Owen J. Kuby- Immunology W.H. Freeman & Company (2019) VIIIth edition

Reference Books

1. Murphy K., and Weaver C. Janeway Immunobiology Garland Exclusive (2016) IXth edition

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Sessionals (May include assignments / quizzes / performance)	100

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT406: BIOANALYTICAL TECHNIQUES

L	T	P	Cr
3	0	0	3.0

Course Objective: The objectives of this course are to provide the students with the understanding of various analytical techniques used in biotechnology-based research and industry. The course will acquaint the students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis.

Syllabus

Sampling and sample preparation: Sample fixing for various analytical applications and sample processing

Introduction to chromatographic techniques: Theoretical basis of chromatographic separations. Column, thin layer, Paper, Normal phase and reverse phase chromatography, Ion-exchange, Affinity and Gas Chromatography, High performance liquid chromatography (HPLC)

Electrophoretic techniques: Theory and application of polyacrylamide and agarose gel electrophoresis, electrophoresis of protein and nucleic acids, Capillary electrophoresis

Centrifugation techniques: Introduction, Basic principle of sedimentation, Centrifuges and their uses, safety aspects in the use of centrifuges. Density gradient and analytical centrifugation

Spectroscopic techniques: Theory and application of UV-VIS, IR, NMR, Fluorescence, Atomic absorption spectroscopy; X-ray diffraction. Introduction to mass spectroscopy

Radioisotopic techniques: Introduction to radioisotopes, detection, measurement and uses of radioisotopes, counting efficiency and autoradiography, biotechnological applications

Microscopy: Principles of microscopy, Light, dark field, fluorescent, UV, transmission and Scanning electron microscopy, Confocal microscopy, microtomy and analysis and measurement of images

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Apply basic principles of different analytical techniques in analytical work.
2. Use spectroscopy and radioactivity in biotechnological applications.

3. Use microscopy, centrifugation and electrophoretic techniques.
4. Demonstrate principle and working of various instruments.
5. Use various techniques for solving industrial and research problems.

Text Books

1. Wilson K., Walker J. Principle and Techniques of Biochemistry and Molecular Biology. Cambridge University Press (2010) 7th edition.
2. Pingoud A., Urbanke C., et al. Biochemical Methods – A concise guide for students and researchers. Wiley (2002).
3. Stryer, A.L., Berg J.A. and Tymoczko, J.L., Biochemistry, W.H.Freeman & Co Ltd (2002).

Reference Books

1. Hawes C., Satiat-Jeunemaitre B. Plant Cell Biology. Oxford University Press (2001) 2nd edition.
2. McHale J.L. Molecular Spectroscopy. Pearson (2008) 1st edition.
3. Zubey, G.L., Principles of Biochemistry, Pearson-Education (2007).
4. Marimuthu R. Microscopy and Microtechniques. MJP Publishers Chennai (2008).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT408: GENETIC & METABOLIC ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objective: This course would familiarize Students with facile molecular techniques involved in isolation and manipulation of genetic material for achieving the desired goal.

Syllabus

Introduction: Scope of genetic engineering, Restriction enzymes and other DNA modifying enzymes used in cloning and other DNA manipulations, essential and desired properties of cloning vectors, examples of cloning and expression vectors, recombinant protein expression in bacteria, yeast and higher eukaryotic systems, rDNA technology in purification of overexpressed recombinant proteins

Genomic and cDNA libraries: Construction and screening of Genomic and cDNA libraries, expression and regulation studies of genes, DNA labelling, nucleic acid hybridization

Applications of genetic engineering: DNA and protein sequencing, Polymerase Chain Reactions (PCR), Site-directed mutagenesis and applications, Molecular markers, Detecting protein-protein interactions, High-throughput techniques, Gene therapy, Genome editing, DNA fingerprinting, RFLP and RAPD

Metabolic Engineering: Introduction, Molecular strategies for rerouting of metabolic pathways in microbes, plants and animals, Various case studies, directed production of novel molecules in microbes and other organisms having therapeutic and industrial values, selection of host-vector system, constraints of the process, genetic instability and host cell mutations

Course Learning Objectives (CLO)
The students will be able to:

1. Design and perform cloning of foreign DNA in an appropriate vector.
2. Select the suitable hosts for a given vector and apply it for cloning or expression of recombinant proteins.
3. Amplify DNA with a target sequence using polymerase chain reaction.
4. Demonstrate application of recombinant DNA technology in various research, industrial, diagnostic and therapeutic applications.
5. Design process for enhanced production of secondary metabolites.

Text Books

1. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
2. J. E. Krebs, E. S. Goldstein, S. T. Kilpatrick, Lewin's Genes XI, International Edition, Pearson Education (2014).
3. Rastogi, S. & Pathak, N., Genetic Engineering, Oxford Higher Education (2009).

Reference Books

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2008).
2. Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).

Evaluation scheme

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT409: ANIMAL BIOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to enable Students to develop basic skills for vertebrate cell culture, maintenance of cell lines and in vitro application of cell and molecular techniques and also to understand the principles of animal cloning and its applications.

Syllabus

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation. Layout of animal tissue culture laboratory.

Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages and their applications.

Primary Culture and Culture of Specific Cell Types: Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity.

Characterization, Contamination and Cryopreservation of Cell Line: Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time, Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cell banks, Transporting cells.

Gene transfer technology in animals: Gene transfer techniques in mammalian cells, Viral and nonviral methods, Production of transgenic animals, ES and microinjection, retroviral method and molecular pharming, applications of transgenic animal technology.

Animal cloning: Animal cloning basic concept, Techniques, relevance and ethical issues, embryo transfer, SCNT, embryo-spliting, embryo sexing, embryos, in situ and ex situ preservation of germplasm, in utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders. Different methods for characterization of animal genomes, SNP, STR, QTL, RFLP and RAPD.

Course Learning Objectives (CLO)
The students will be able to

1. Explain the fundamental scientific principles that underlie cell culture
2. Acquire knowledge for isolation, maintaince and growth of cells.
3. Develop proficiency in establishing and maintaining of cell lines.
4. Acquire knowledge in animal cloning and its applications

Text Books

1. R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, 4th Edition" 2000.
2. Ranga, M.M., Animal Biotechnology, Agrobios (2007) 2nded.

Reference Books

1. Masters, J. R.W., Animal Cell Culture, Oxford (2000) 3rded.
2. Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT410: PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

Syllabus

Introduction, Aim and Scope of Plant Biotechnology: Major challenges and prospects of traditional and modern plant biotechnology, Important milestones of plant biotechnology

Plant Tissue Culture and protoplast culture—its history, development and applications, Plant tissue culture media, Plant growth regulators, Types of cultures, Protoplast culture and somatic hybridization.

Micropropagation: Techniques and various steps involved in micropropagation, Production of disease-free plants and certification of tissue culture raised plants.

Production of Haploid Plants: Androgenesis and Gynogenesis, Significance and uses of haploids. Embryo culture and embryo rescue and its applications in plant improvement.

Strategies for Producing Novel Plants: Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, direct and indirect gene transfer methods, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, various strategies for the improvement of crop yield and quality, Applications of plant transformations/ transgenics, Molecular farming of commercially/pharmaceutically important products.

Secondary Metabolite Extraction: Primary vs secondary metabolites, Role of plant tissue culture in secondary metabolite production, Hairy root culture, Strategies for the enhancement of secondary metabolite production.

Germplasm Conservation and Somaclonal Variations: Isolation of somaclonal variants, Applications and limitations of somaclonal variations, Gametoclonal variations. Germplasm and methods of its conservation and Cryopreservation

Self-Learning: Transgenics-Issues and Concerns, Biosafety, Societal and ethical concerns on genetically modified foods and crops.

Course Learning Objectives (CLO)
The students will be able to:

1. Familiarize with organization of PTC Lab., aseptic manipulations and learn techniques of culturing tissues, single cells, protoplast and anther culture, hairy root culture and germplasm conservation.
2. Undertake large scale in vitro propagation of plants through micropropagation.
3. Generate plants with desirable/novel traits through genetic manipulations using different methods of gene transfer and marker associated selections.
4. Recognize the importance of plant secondary metabolites, their commercial production.

Text Books

1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008).
2. Chawala, HS, Introduction to Plant Biotechnology, Third Edition, Oxford & IBH (2017).
3. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing (2006).

Reference Books

1. Satyanarayana, U., Yeast Biotechnology: Diversity and Applications, Springer (2009).
2. Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessionals (May include Assignments/Quizes)	30

UBT411: ANIMAL AND PLANT BIOTECHNOLOGY LAB

L	T	P	Cr
0	0	4	2.0

Course Objectives: The course will enable the students to design and undertake various experiments in genetic and metabolic engineering, animal biotechnology and plant biotechnology

Detail contents:

Laboratory design and layout for animal and plant tissue culture, To check for bacterial and fungal contamination in the tissue culture laboratory, Preparation of animal and plant tissue culture media, Isolation of mononuclear cells and cell counting and viability, To carry out surface disinfection and establishment of aseptic cultures of plant tissue, Lymphocyte cell culture, To study the effect of plant growth regulators on morphogenesis, To test the kanamycin resistance in plant tissue to identify selection marker for genetic transformation, Preparation of competent cells and genetic transformation of *Agrobacterium tumefaciens* using the freeze-thaw method, To perform the histochemical assay for the analysis of putative transformed tissue, To confirm the stable genetic transformation by amplification of the selection marker gene, To design primers for the amplification of a given gene sequence, To test the clonal fidelity of micropropagated plants using RAPD markers, SNP genotyping by PCR-RFLP method.

Course Learning Outcomes (CLO):

Students will be able to

1. design the animal and plant tissue culture labs
2. prepare media for plant and animal tissue culture
3. induce various morphogenetic events in plant tissue culture
4. undertake plant genetic transformation and genotyping

Text Books:

1. Experiments in Plant Tissue Culture By Johan H Dodds and Lorin W Roberts. Publishers: Press Syndicate of University of Cambridge, 1990
2. Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 8th Edition 2010
3. Molecular cloning. A laboratory manual by T Maniatis, E F Fritsch and J Sambrook. pp 545. Cold Spring Harbor Laboratory, New York

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

Reference Book:

1. Masters, J. R.W., Animal Cell Culture, Oxford (2000) 3rd edition
2. Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Sessionals (May include assignments / quizzes / performance)	100

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT515: BIOSTATISTICS

L	T	P	Cr
2	0	0	2.0

Course Objective: Students will learn about descriptive and inferential statistics and its application in biological data analysis.

Syllabus

Descriptive Statistics: Biology and statistics, Variables and data, Sampling and sampling errors in biological data, Sampling techniques, measures of central tendency, measures of dispersion and variability, Permutations and combinations, Probability, addition and multiplication of probabilities, normal, binomial and Poisson distributions, Binomial and Poisson probabilities, prior probabilities, posterior probabilities and Bayes' theorem.

Hypothesis Testing: Test of hypotheses, one and two sample analysis, Paired sample analysis, Nonparametric statistics and limitations. Confidence limits and tests of confidence, Single, Two and Multifactorial analysis, Non-parametric Analysis of Variance (Kruskal-Wallis test), Multiple comparison tests – Tukey, Newman Keul, Dunnett's test, Scheffe's tests, Contingency tables, Chi-square goodness of fit test.

Regression and Correlation Analysis: Concept of least squares, Simple linear regression, residual sum of squares, regression coefficients, covariance, Pearson coefficient of correlation, coefficient of determination, hypothesis about correlation coefficient, Rank correlation.

Design of Experiments and Data Presentation: Blocking factors, Latin square design, Factorial experiments, Response Surface Methods, Survivorship curves, Graph plotting and significance of Curves, Data representation.

Course Learning Objectives (CLO)
The students will be able to:

1. Classify various types of data and apply basic statistical concepts such as measure of central tendencies, measure of dispersion and sampling.
2. Apply concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis.
3. Perform statistical hypothesis testing using tools such as t-test, ANOVA, Chi-square test.
4. Design experiments and solve problems based on relationships among multiple variables.

Text Books

1. Zar, J. H., Biostatistical Analysis. Pearson Education (2014) 5th Edition.
2. Banerjee, B., Mahajan's Methods in biostatistics for medical students and research workers. Jaypee Brothers Medical Publishers (2018) 9th Edition.
3. Montgomery, D. C., Design and Analysis of Experiments. John Wiley & Sons, Inc. (2009) 7th Edition.

Reference Books

1. Rao, K. V., Biostatistics – A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers (2009) 2nd Edition.
2. Daniel, W. W. & Cross, C. L., Biostatistics: A Foundation for Analysis in the Health Sciences, Wiley Series in Probability and Statistics (2013).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include Assignments/Quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT516: BIOINFORMATICS

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to familiarize Students with basic concepts of sequences, structural alignment, database searching, protein structure prediction and applications.

Syllabus

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats, Biological databases. Types of biological databases, its classification, application and pitfalls. Information retrieval from biological databases

Pairwise sequence alignment and database searching: Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Scoring matrices, Methods of sequence alignment e.g., Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA and BLAST

Multiple sequence alignment and phylogenetics: Scoring multiple sequence alignments, Progressive alignment method, Iterative alignment method, Block-based alignment, Molecular evolution and phylogenetics, Phylogenetic analysis

Structural Bioinformatics: Protein structure basics, Visualization, Classification. Protein secondary structure prediction**.** Protein tertiary structure prediction: methods, applications, RNA structures, Genomics and proteomics. Machine learning in structure prediction

Laboratory Work*:* Biological database, file formats, Local and global sequence alignment of protein and DNA sequences, Phylogenetic tree construction, Sequence search and annotation

Course Learning Objectives (CLO)
The students will be able to:

1. Explore biological databases
2. Perform pairwise and multiple sequences alignment
3. Construct phylogenetic tree, analyze and make inferences from it.
4. Analyze sequence and structure of bio-macromolecule data.

Text Books

1. Xiong J, Essential Bioinformatics, Cambridge University Press (2013).
2. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour

Laboratory Press (2001), 2nd ed.

3. Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2010).

Reference Books

1. Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks- A Practical Approach, Oxford University Press (2000).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments /quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT517: BIOPROCESS ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective of the course is to apply fundamental principles and concepts of chemical engineering to biological systems. This course will provide a comprehensive understanding of media formulations, microbial growth kinetics, bioreactor selection, upstream & fermentation processes, and its role in manufacturing bio-products.

Introduction: Introduction to bioprocess engineering, Interaction of two disciplines: biotechnology and bioprocess engineering, outline of unit operations involved in upstream and downstream processing, steps in bioprocess development, role of bioprocess engineer in the biotechnology industry, historical advancement in bioprocess technology, range of microbial diversity, process and products relating to bioprocess engineering.

Microbial Growth Kinetics: Growth, growth measurement, media formulation, simple and complex media, media sterilization, Del factor, design of batch and continuous sterilization, log penetration theory, scale up of sterilization process, filter design, screening, culturing, culture preservation, strain improvement, inoculum preparation, stoichiometry of cell growth and product formation, elemental balances- degrees of reduction, factors influencing product formation on varying carbon & nitrogen source, batch culture, Monod's kinetics, modelling of batch growth kinetics, environmental factors affecting microbial growth, continuous culture, an ideal chemostat, advantages and limitations of continuous over batch culture, fed-batch culture and its applications.

Bioreactor Selection, Design and Process Control: Overview of reactor, mass balance in bioreactor, design equations of bioreactors, selection criteria for bioreactor, body construction of fermenter and its components i.e., impellers, stirred glands and bearings, seal assemblies, baffles, sparger and valves, solid state and submerged fermentation, design aspects of bubble column bioreactor, air-lift fermenter, plug-flow and packed bed bioreactor, scaling up of bioreactor. Main parameters to be monitored and controlled in fermentation processes, control systems in a bioprocess, methods of measuring process variables i.e., temperature, pressure, flow, dissolved oxygen, pH, role of computers in fermentation process analysis.

Transport Phenomenon in Bioreactor: Fick's law, theories of mass transfer, mass transfer between two phases, role of aeration and agitation in a bioprocess, oxygen transfer methodology in a fermentation process, significance of volumetric transfer coefficient (KL_a) and its determination, factors affecting KL_a values in a bioreactor, power requirements in gassed and un-gassed bioreactors.

Course Learning Objectives (CLO)
The students will be able to:

1. Explain how microorganisms and biochemical processes can be applied in engineered systems.
2. Distinguish among batch, continuous and fed-batch culture systems for the production of biochemical products.
3. Describe microbial growth & cultivation, various bioreactor components, and types of bioreactors used in biotechnology industries
4. Design media sterilization and design of air filter in a bioprocess.
5. Apply various concepts to improve bioreactor performance and evaluate process variables to analyse a bioprocess.

Text Books

1. Stanbury PF, Hall SJ, and Whitaker A, Principles of Fermentation Technology, 3rd Edition, Elsevier (2016).
2. Shuler ML and Kargi F, Bioprocess Engineering, 2nd Edition Prentice Hall (2015).
3. Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2006).
4. Belter PA, Cussler E and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (1988)

Reference Books

1. Doran P M, Bioprocess Engineering Principles, 2nd Edition, Academic Press (2012).
2. Ahuja S, Handbook of Bioseparations, Academic Press (2000).
3. Harrison RG, Bioseparations: Science and Engineering, Oxford University Press (2015).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessional (May include Assignments/Projects/Tutorials/Quizzes)	30

UBT407: TRANSDUCERS AND BIOSENSORS

L	T	P	Cr
3	0	2	4.0

Course Objective: The course aims to impart knowledge on basic concepts of transducers and acquaint the students with different types of electrodes used in bio-potential recording. The course will also provide understanding of biosensors, optical and ultrasonic sensors.

Syllabus

Physiological Transducers: Transducers in general, active and passive transducers, pressure transducers, catheter tip pressure transducers, temperature transducers, pulse sensors, respiration sensors, digital transducers, selection criteria for transducers.

Bioelectric potentials/Physiological signals: Action potentials and impulse propagation, origin of bioelectric signals, electrode theory, types of electrodes, selection criteria for electrodes recording electrodes and skin-contact impedances, electrical conductivity and microelectrodes, pulse, temperature, pressure and repression sensors.

Biosensors: Benefits of biosensors, Types of biosensors, potentiometry, Bio-chemical sensors, chemical potential and equilibrium - some famous examples - electrochemical cell at equilibrium - Nernst equation - pH electrode - Ion-sensitive electrodes, voltammetry, amperometry, conductimetry.

Ultrasonic, Optical & Laser biosensors: Basics of ultrasound, theory, characteristics, design, applications in medical science for diagnostic and therapeutic, Optical fiber sensor, Polarization, Refractive index, Light scattering, micro-opto- electromechanical system [MOEMS], Laser in industry.

Signal processing: Introduction to biomedical signal processing and analysis; Wheatstone bridge, Bioelectric amplifiers, instrumentation amplifier, Introduction to active filters, First order, second order and higher order filters, Modulation and demodulation.

Laboratory Work (if applicable):

Experiments based on strain gauge, LVDT, capacitance, photoelectric, piezoelectric and temperature. Also, experiments for digital sensor, LDR, resistivity measurement.

Course Learning Objectives (CLO)
The students will be able to:

1. Explain basic concepts of transducers
2. Elucidate different types of electrodes used in bio-potential recording
3. Differentiate biosensors, optical and ultrasonic sensors

4. Analyze, formulate and select suitable sensor/biosensor.

Text Books

1. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.
2. Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.

Reference Books

1. A.K. Sawhney and Puneet Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai, 2014
2. Florinel-Gabriel Banica, Chemical Sensors and Biosensors: Fundamentals and Applications, Wiley, 2012

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

UTA025: INNOVATION AND ENTREPRENEURSHIP
(2 SELF-EFFORTS HOURS)

L	T	P	Cr
1	0	2#	3.0

Course Objective: This course aims to provide the students with a basic understanding in the field of entrepreneurship, entrepreneurial perspectives, concepts and frameworks useful for analyzing entrepreneurial opportunities, understanding eco-system stakeholders and comprehending entrepreneurial decision making. It also intends to build competence with respect business model canvas and build understanding with respect to the domain of start-up venture finance.

Syllabus

Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioural; entrepreneurial challenges.

Entrepreneurial Opportunities: Opportunities- discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering.

Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, - Effectuation and Causation.

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions - conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.

Organizing Business and Entrepreneurial Finance: Forms of business organizations; organizational structures; Evolution of organization, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain the fundamentals behind the entrepreneurial personality and their intentions.
2. Discover/create and evaluate opportunities.
3. Identify various stakeholders for the idea and develop value proposition for the same.
4. Describe various Business Models and design a business model canvas.

5. Analyse and select suitable finance and revenue models for start-up venture.

Text Books

1. Ries, Eric (2011), The lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited.
2. Blank, Steve (2013), The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, K&S Ranch.
3. S. Carter and D. Jones-Evans, Enterprise and small business- Principal Practice and Policy, Pearson Education (2006)

Reference Books

1. T. H. Byers, R. C. Dorf, A. Nelson, Technology Ventures: From Idea to Enterprise, McGraw Hill (2013).
2. Osterwalder, Alex and Pigneur, Yves (2010) Business Model Generation.
3. Kachru, Upendra, India Land of a Billion Entrepreneurs, Pearson.
4. Bagchi, Subroto, (2008), Go Kiss the World: Life Lessons For the Young Professional, Portfolio Penguin.
5. Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business, Penguin Books.
6. Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIM Ahmedabad.
7. Bansal, Rashmi, (2013). Follow Every Rainbow, Westland.
8. Mitra, Sramana (2008), Entrepreneur Journeys (Volume 1), Booksurge Publishing.
9. Abrams, R. (2006). Six-week Start-up, Prentice-Hall of India.
10. Verstraete, T. and Laffitte, E.J. (2011). A Business Model of Entrepreneurship, Edward Elgar Publishing.
11. Johnson, Steven (2011). Where Good Ideas comes from, Penguin Books Limited.
12. Gabor, Michael E. (2013), Awakening the Entrepreneur Within, Primento.
13. Guillebeau, Chris (2012), The $100 startup: Fire your Boss, Do what you love and work better to live more, Pan Macmillan.
14. Kelley, Tom (2011), The ten faces of innovation, Currency Doubleday.
15. Prasad, Rohit (2013), Start-up sutra: what the angels won't tell you about business and life, Hachette India.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessionals (Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT518: BIOSTATISTICS AND OMICS LAB

L	T	P	Cr
0	0	3	1.5

Course objective: The course aims to make students understand and apply biostatistics and bioinformatics tools for storage, retrieval and analysis of biological sequence and structure data. The course will allow students to learn application of statistics on biological data.

Detail contents:

Biostatistics

Descriptive statistical analysis of given data (Measures of central tendency and measures of dispersion and variability), Analyse relationship between tow variables by correlation and regression analysis, Statistical tests (t-test, ANOVA, Chi-square test)

Omics

To explore DNA sequence databases such as GenBank, EMBL, NCBI; Retrieve, FASTA sequence from GenBank database and perform sequence analysis, To explore protein sequence databases such as UniProt, PROSITE, PFAM and retrieve comprehensive information of give protein, To study protein 3D structure databases using PDB, PDBsum, CATH and SCOP, Database, To study pairwise, global and multiple sequence alignment: Emboss Needle, Emboss

Water, Clustal Omega, MUSCLE, MAFFT and T-COFFEE, To perform homology searches using BLAST and its variants, Construction of phylogenetic tree using MEGA software, To find interactions among proteins using STRING, Retrieving DNA from UCSC genome browser and NCBI and Gene prediction using AUGUSTUS, To search CpG islands and ORF in genomic DNA sequences, To search for open reading frames in a given DNA sequence, To predict post translational modifications in given protein sequences, To predict RNA structure, To predict tertiary structure for an amino acid sequence using SWISS-MODEL,

Course Learning Outcomes (CLO):

The students will be able to

1. Explore biological databases and retrieve relevant data from them
2. Perform pairwise and multiple sequences alignment, construct phylogenetic tree, analyze and make inferences from it.

3. Analyze sequence and structure of bio-macromolecule data.
4. Analyze biological data using basic statistical concepts such as measure of central tendencies, measure of dispersion and sampling.
5. Perform statistical hypothesis testing using tools such as t-test, ANOVA, Chi-square test

Reference Books:

1. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001)
2. Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks A Practical Approach, Oxford University Press (2000).
3. Zar, J. H., Biostatistical Analysis. Pearson Education (2014) 5th Edition.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Sessionals (May include assignments / quizzes / performance)	100

UHU005: HUMANITIES FOR ENGINEERS

L	T	P	Cr
2	0	2	3.0

Course Objective: The objective of the course is to understand the interplay between, psychological, ethical and economic principles in governing human behaviour. The course is designed to help the students to understand the basic principles underlying economic behaviour, to acquaint students with the major perspectives in psychology to understand human mind and behavior and to provide an understanding about the how ethical principles and values serve as a guide to behavior on a personal level and within professions.

Syllabus

UNIT I: PSYCHOLOGICAL PERSPECTIVE

Introduction to Psychology: Historical Background, Psychology as a science. Different perspectives in Psychology.

Perception and Learning: Determinants of perception, Learning theories, Behavior Modification.

Motivational and Affective basis of Behaviour: Basic Motives and their applications at work.

Components of emotions, Cognition and Emotion. Emotional Intelligence.

Group Dynamics and Interpersonal relationships.

Development of self and personality.

Transactional Analysis.

Culture and Mind.

Laboratory work:

1. Experiments on learning and behaviour modification.
2. Application of Motivation Theories: Need based assessment.
3. Experiments on understanding Emotions and their expressions.
4. Personality Assessment.
5. Exercises on Transactional analysis.
6. Role plays, case studies, simulation tests on human behaviour.

UNIT II: HUMAN VALUES AND ETHICAL PERSPECTIVE

Values: Introduction to Values, Allport-Vernon Study of Values, Rokeach Value Survey, Instrumental and Terminal Values.

Value Spectrum for a Good Life: Role of Different Types of Values such as Individual, Societal, Material, Spiritual, Moral, and Psychological in living a good life.

Moral and Ethical Values: Types of Morality, Kant's Principles of Morality, Factors for taking ethical decisions, Kohlberg's Theory of Moral Development.

Analyzing Individual human values such as Creativity, Freedom, Wisdom, Love and Trust.

Professional Ethics and Professional Ethos, Codes of Conduct, Whistle-blowing, Corporate Social responsibility.

Laboratory Work:
Practical application of these concepts by means of Discussions, Role-plays and Presentations, Analysis of Case studies on ethics in business and CSR.

UNIT III: ECONOMIC PERSPECTIVE
Basics of Demand and Supply
Production and cost analysis
Market Structure: Perfect and Imperfect Markets.
Investment Decisions: capital Budgeting, Methods of Project Appraisal.
Macroeconomic Issues: Gross domestic product (GDP), Inflation and Financial Markets.
Globalisation: Meaning, General Agreement on Trade and tariffs (GATT), World Trade Organisation (WTO). Global Liberalisation and its impact on Indian Economy.

Laboratory Work:
The practicals will cover numerical on demand, supply, market structures and capital budgeting, Trading games on financial markets, Group discussions and presentations on macroeconomicissues. The practicals will also cover case study analysis on openness and globalisation and the impact of these changes on world and Indian economy.

Micro Project: Global Shifts and the impact of these changes on world and Indian economy.
Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Improve the understanding of human behavior with the help of interplay of professional, psychological and economic activities.
2. Able to apply the knowledge of basic principles of psychology, economics and ethics for the solution of engineering problems.
3. Explain the impact of contemporary issues in psychology, economics and ethical principles on engineering.

Text Books

1. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, McGraw Hill Book Co(International Student (1986).
2. A. N. Tripathi, Human Values, New Age International (P) Ltd (2009).
3. Krugman, Paul and Wells Robin, Economics, W.H. Freeman & Co Ltd. Fourth Edition (2015).
4. Rubinfeld Pindyck. Microeconomic Theory and application, Pearson Education New Delhi (2012).
5. Samuelson, Paul, A. and Nordhaus, William, D. Economics, McGraw Hill, (2009).
6. Mankiw, Gregory N. Principles of Macroeconomics, South-Western College Pub., (2014).

7. Gregory, Paul R. and Stuart, Robert C. The Global Economy and Its Economic Systems, 2013 South-Western College Pub (2013).

Reference Books

1. Atkinson, R.L., Atkinson, R.C., Smith, E.E., Bem, D.J. and Nolen-Hoeksema, S. (2000). Hilgard's Introduction to Psychology, New York: Harcourt College Publishers.
2. Berne, Eric (1964). Games People Play – The Basic Hand Book of Transactional Analysis. New York: Ballantine Books.
3. Ferrell, O. C and Ferrell, John Fraedrich Business Ethics: Ethical Decision Making & Cases, Cengage Learning (2014).
4. Duane P. Schultz and Sydney Ellen Schultz, Theories of Personality, Cengage Learning, (2008).
5. Saleem Shaikh. Business Environment, Pearson (2007).
6. Chernilam, Francis International Buisness-Text and Cases, Prentice Hall (2013).
7. Salvatore, Dominick, Srivastav, Rakesh., Managerial Economics: Principles with Worldwide Applications, Oxford, 2012.
8. Peterson H. Craig. and. Lewis, W. Cris. Managerial Economics, Macmillan Pub Co; (1990).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessionals (Include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	30

UBT618: DOWNSTREAM PROCESSING

L	T	P	Cr
3	0	0	3.0

Course Objective: The course provides fundamental concepts of various downstream purification steps involved in a bioprocess industry.

Syllabus

Introduction: Basic concepts of separation technology, overview of major upstream and downstream processes, importance of downstream processing in biotechnology, economic evaluation of downstream processing, separation characteristics of biological molecules, generic scheme of bioseparation, modern separation technology in bioprocessing.

Primary Isolation and Recovery: Selection of purification methodologies, biomass removal and disruption by physical, chemical and biological methods, Types of Homogenizers, Types of filters (vacuum filter, plate and frame filter, leaf filter), Advanced Centrifugation, Theory of centrifugation, Types of centrifuges (tubular bowl centrifuge, basket centrifuge, ultracentrifuge), Precipitation, Coagulation and flocculation.

Membrane based Separation, Extraction and Adsorption: Membrane process, ultrafiltration, nanofiltration, reverse osmosis, dialysis, Extraction, liquid-liquid extraction, Batch extractions, staged extractions, solvent recovery, applications of extraction. Evaporation, Types of evaporation, Adsorption, adsorbents types, their preparation and properties, types of adsorption isotherms and their importance in bioprocessing, adsorption in fixed bed.

Chromatography, Drying and Case Studies: General theory, partition coefficient, types of chromatography: Ion exchange, gel permeation, affinity, HPLC, Crystallization: Batch and continuous crystallization, crystallization equipment, Principles of drying (Water content in biological products), Heat transfer modes: Conduction, Natural and Forced Convection, Radiation, Design and Operation of Drying Equipment: Hot-air oven, Spray dryer, Vacuum dryer , Freeze dryer, Case studies: Downstream processing of baker's yeast and citric acid.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend the interplay between upstream and downstream processes.
2. Describe the main stages of downstream processing operations.
3. Explain the principles of major downstream operations used in a bioprocess industry such as filtration, centrifugation, extraction and chromatography.

4. Apply different techniques such as precipitation, coagulation and flocculation in downstream processing
5. Design recovery outline in polishing of a product employing crystallization and drying methods.

Text Books

1. Belter PA, Cussler E and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (1988).
2. Harrison RG, Bioseparations: Science and Engineering, Oxford University Press (2015).
3. Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2006).

Reference Books

1. Ahuja S, Handbook of Bioseparations, Academic Press (2000).
2. G. Subramanian-Bioseparation and Bioprocessing: Biochromatography, membrane separations, modeling, validation, Vol-I, Wiley-VCH Verlag GmbH Germany (1998).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessional (May include Assignments/Projects/Quizzes)	30

UBT619: PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to make students understand the basic concepts involved in pharmaceutical industry. The course will give knowledge about new drug development and approval process, ADMET of drugs, about the manufacturing and quality control of conventional, new type of dosage forms and biotechnology derived pharmaceuticals.

Syllabus

Introduction to drugs and pharmacy: An overview and history of pharmaceutical industry. The business and the future of Biopharmaceuticals. Drug regulation and control. Scope and applications of biotechnology in pharmacy. New drug development and approval process: Strategies for new drug discovery, finding a lead compound, combinatorial approaches to new drug discovery, pre-clinical and clinical trials

Drug pharmacokinetics & pharmacodynamics: Routes of drug administration, membrane transport of drugs, absorption, distribution, metabolism and excretion of drugs. Factors modifying drug action, mechanism of drug action on human beings, receptor theory of drug action, pharmacogenomics, adverse effects of drugs and toxicology, Drug interactions

Pharmaceutical manufacturing: Drug dosage forms and their classification. Sterile dosage forms- parenteral and biologics, novel dosage forms and targeted drug delivery systems. Current good manufacturing practices and issues. Quality control of pharmaceutical products as per pharmacopoeia. Stability studies, Method validation

Biotechnology derived pharmaceuticals: Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Drug regulatory requirement of India, Drug regulatory and accrediting agencies of the world (USFDA, TGA, ICH, WHO, ISO etc.). Overview of registration process of Indian drug product in overseas market

Course Learning Objectives (CLO)
The students will be able to:

1. explain the regulatory aspects and various steps of new drug discovery process.
2. explain the concept of pharmacodynamics and pharmacokinetics.
3. apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones.
4. carry out the quality control procedures in the production of various biopharmaceuticals.

Text Books

1. Allen, L.V., Popovich, N.G. and Ansel, H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins (2005).
2. Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, Wiley (1998).

Reference Books

1. Gennaro, A.R., Remington: The Science and Practice of Pharmacy. Lippincott Williams and Wilkins (2005).
2. Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2008).

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT614: BIOSAFETY, BIOETHICS & IPR

L	T	P	Cr
2	0	0	2.0

Course Objective: To introduce basic concepts of ethics and safety that are essential for all basic and applied sciences. To understand balanced integration of scientific and social knowledge and its protection in sustainable development.

Syllabus

Biosafety: Evolution of the concept of biosafety; biohazard, need and application of biosafety in laboratories and industries; biosafety guidelines, regulations and their implementation; Classification and Description of Biosafety levels; Design of clean rooms and types of biosafety cabinets; Risk assessment and containment levels through case studies; bio-medical and hazardous wastes; Good laboratory practice (GLP); bio-terrorism; Convention on biodiversity and Cartagena protocol on biosafety; types of risk and issues associated with GMO's for animal, human, agriculture and environment.

Bioethics: Introduction and need of bioethics, its relation with other branches, Ethical Issues involving GMOs; ethics related to human cloning, prenatal diagnosis, agriculture and animal rights through case studies; Socio-economic impact of biotechnology.

Intellectual Property Rights (IPR): Introduction to IPR, types of IP (patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs), treaties in IPR, Patent laws, Legislations covering IPR's in India, IPR Protection, patent filing in biotechnology, provisional and complete specification, patentable and non-patentable items.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life.
2. Recognize importance of biosafety practices and guidelines in research.
3. Comprehend benefits of GM technology and related issues.
4. Recognize importance of protection of new knowledge and innovations and its role in business.

Text Books

1. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008).
2. Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).
3. Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997).

Reference Books

1. Narayan, P., Patent Law, Eastern Law House (1975).
2. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
3. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT891: CAPSTONE PROJECT

L	T	P	Cr
1	0	2	8.0

Course Objective: To give a multifaceted assignment that serves as a culminating academic and intellectual experience for Students. To design and implement integrated approach to biological systems using concepts of biological and engineering sciences. To plan the process for the designed product and analyze the prototype manufactured for improvement in design and function

Syllabus

Scope of work: Each Students group led by a team leader will develop a design project involving formulation of problem, requirement, execution of the project and analysis. The students will prepare a scientific report and powerpoint/ poster presentation. Depending on the type of project, design problem will be executed by simulation/modelling or developing a product

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. formulate a design based project
2. implement ideas to solve the real time problems
3. work in a group and coordinate each other
4. present and defend the work done in front of the committee

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Formulation of the problem and objectives	10
2.	Execution of the project	20
3.	Results and data interpretation	20
4.	Technical report	20
5.	Presentation cum viva	30

UBT615: JOURNAL CLUB

L	T	P	Cr
0	0	0	2.0

Course Objective: The Journal club course will provide an opportunity to the students to learn selection of relevant research articles, comprehending it well enough to be able to present it explaining to the audience

Scope of the course: The Students will be asked to select a recent research article related to a given topic. The student will read the paper and read other related or quoted papers for effective understanding. Finally, student will present the paper and defend the results. The exercise will enable the students to read and understand the finding of a paper. They will learn how to design experiments to address a scientific problem, note down observations, infer results and present them in an appropriate way and discuss the results defending them. The discussion will also highlight importance of the findings.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)

The students will be able to:

1. select a paper related to a given topic
2. design experiments to address a scientific problem
3. analyze the observation to infer results
4. discuss the research finding in reference with the existing knowledge in the field.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Presentation of a research paper	100

UBT620: PROCESS LAB

L	T	P	Cr
0	0	4	2.0

Course objective: The objective of the course is to apply fundamental principles and concepts of bioprocess engineering in bioreactor selection along with its role in manufacturing, processing, and quality control of bioproducts, food, and pharmaceuticals.

Detail contents:

Bioprocess Engineering: Study of thermal death kinetics of microbe, Production of citric acid and lactic acid, comparative study on rate of product formation using immobilized and suspended cells, determination of oxygen uptake rate (OUR) under static and agitated conditions, comparative assessment of cell disruption methods, optimization of flocculating agent concentration, estimation of filtration efficiency of different filter membranes, assessment of adsorption kinetics of phosphate, salting out method for protein precipitation, quantitative and qualitative estimation of products using GC-MS and HPLC, Determination of enzyme kinetics parameters K_m and V_{max}

Pharmaceutical Technology: Quality control of antibiotic and non-antibiotic formulations using titrimetric, spectrophotometric and chromatographic methods as per IP/US Pharmacopoeia, Microbiological assay of the given test antibiotic by cylindrical plate and turbidimetric method and to determine MIC, Sterility testing of formulations: Water for injection, sodium chloride for injection and eye drops

Course Learning Outcomes (CLO):

Students will be able to

1. Comprehend the kinetics of growth and product formation for microbes using different substrates and operational conditions.
2. Understand various primary isolation, recovery and purification operations in bioprocess industries.
3. Analyze the comparative efficiency of food processing and preservation techniques.
4. Chemical and microbiological assays for determining the quality of pharmaceuticals

Textbooks

1. Stanbury PF, Hall SJ, and Whitaker A, Principles of Fermentation Technology, 3rd Edition, Elsevier (2016).

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

2. Shuler ML and Kargi F, Bioprocess Engineering, 2nd Edition Prentice Hall (2015).
3. Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2006).
4. Belter PA, Cussler E and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (1988).

Reference Books

1. Arvind N. Shukla, Laboratory Bioprocess Technology, Discovery Publishing House (2013).
2. Sharma SK, Mulvaney SJ, Rizvi SHS, Food Process Engineering: Theory and Laboratory Experiments, John Wiley & Sons Inc; 1st edition (30 November 1999); CBS Publishers & Distributors Pvt. Ltd.
3. Indian Pharmacopoeia

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Sessionals (May include assignments / quizzes / performance)	100

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT796: PROJECT SEMESTER

L	T	P	Cr
0	0	0	15.0

Course Objective: The semester project is aimed to impart an in-depth and thorough training on some specific industrial problems. Such exposures would enable the students to address the various real-time challenges prevalent in biotech-based industries. The students acquire experience and knowledge to work in professional setup. The students will understand the challenges faced by industries and research laboratories and the possible solutions. During this period, the students will get training in the diverse areas of biotechnology

Scope of Training: The Students will get opportunity to be a part of ongoing QA, QC, Production, and R&D activities in different industries, commercial enterprises and organization. The students can also join laboratories in research institutes and reputed universities. The students will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The students will develop understanding of biosafety, bio-ethic, regulatory and compliances. The students will acquire skill to write, analyze and compile data, and present the detailed technical/scientific report. At the end of successful project semester training, potentially the students become employable in the industries/organizations**.**

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. work in a team
2. adapt to the varying working environment in industry and research institute
3. identify a problem in biotechnology based industry.
4. formulate a research problem in research laboratory
5. design experiments to solve the industrial/research problem.
6. compile and/or interpret the industrial data.
7. analyze and interpret the experimental data

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Formulation of the problem and objectives	10
2.	Execution of the project	20
3.	Results and data interpretation	20
4.	Technical report	20
5.	Presentation cum viva	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT797: PROJECT

L	T	P	Cr
0	0	0	8.0

Course Objective: The semester project is aimed to impart an in-house project training on some specific scientific problems. Such exposures would enable the Students to learn identification of a scientific problem, search research literature, plan and execute experiment seeking a solution to the problem.

Scope of Training: The Students will get opportunity to perform an in-house research project under the guidance of one of the faculty members. The Students will gain experience in different sectors of biotechnology viz food, medicine and pharmaceutical sciences. The students will acquire skill to write, analyze and compile data, and present the detailed technical/scientific report. At the end of successful project training, potentially the students become employable in the industries or better prepared for higher education.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. formulate a research problem.
2. design experiments based on the relevant research literature.
3. apply biotechnological techniques to perform experiments.
4. analyze data.
5. compile and present results of a research project.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	Technical report	30
2.	Presentation cum viva	70

UBT705: GENOMICS AND PROTEOMICS

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective of this course is to familiarize Students with concepts of genomics and proteomics technologies and to understand the steps of high throughput data analysis.

Syllabus

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats, Biological databases. Types of biological databases, its classification, application and pitfalls. Information retrieval from biological databases, pairwise sequence alignment and database searching**:** Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Scoring matrices, Methods of sequence alignment e.g., Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA and BLAST.

Genomics and Transcriptomics: Structure of Gene and genomes of Eukaryotic and prokaryotic, genome databases, Sanger sequencing-principle, methodology and applications, Whole genome - de novo sequencing or resequencing; exome sequencing, RNA sequencing; small RNA sequencing; Next Generation Sequencing (NGS) workflow, Differential expression.

NGS Data Analysis: NGS work flow and pipeline for data analysis. Next generation sequence data analyses, Data format, Quality control-Phred score; FastQC and FastX tool kits, read length, read depth, sequence coverage, Homology (orthology groups), Genome alignment and analysis tools- BWA (BurrowsWheeler Aligner), SAMtools, GATK (The Genome Analysis Toolkit), Cuffcompare, Velvet, Oases, Trinity.

Proteomics: Introduction to quantitative proteomics- Differential proteomics, post-translational modifications, Proteogenomic Concepts and principles of genome annotation, genome search specific peptides, alternative translation initiation, small ORFs, Analysis of transcriptomic and proteomic data for genome annotation; Gene prediction algorithms.

Structural Bioinformatics: Protein structure basics, Visualization, Classification. Protein secondary structure prediction**.** Protein tertiary structure prediction: methods, applications, RNA structures, Genomics and proteomics.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explore biological databases
2. Perform pre-processing of NGS data
3. Analyze the algorithms to handle NGS data
4. Comprehend various methods involved in data analysis of genomics and proteomics technology for commercial and industrial applications.

Text Books

1. Xiong J, Essential Bioinformatics, Cambridge University Press (2013).
2. S B Primrose and R Twyman, Principles of gene manipulation and Genomics (2013) 7th Edition.
3. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed.
4. Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2010).

Reference Books

1. Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2010).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments /quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT706: ENZYME TECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: The objective of the course is to inform the students about isolation of novel enzymes, basic principles for optimization, modeling of the industrial use of the enzymes etc. in which both, free and immobilized enzymes play a role. Students will be able to implement both biochemical and engineering knowledge in order to design new and improve current enzymatic processes.

Syllabus

Introduction to enzymes: Enzymes-historical resume, Nomenclature and Classification, Biological roles, Isozymes, Marker enzymes, Overview of enzyme 3D-structure, active site, catalytic site, Specific activity, Enzyme activity and kinetics of free enzymes, K_m, V_{max}, and turn over number of enzymes and their significance, Modifiers of enzyme activity, enzyme activators, enzyme inhibitors, Overview of enzyme inhibition kinetics: competitive, non-competitive, and un-competitive, Kinetics of enzyme degradation, Enzyme stability: pH, temperature.

Production of enzymes: Sources of industrial enzymes (natural & recombinant), Screening for new and improved enzymes, different methods of extraction, isolation and purification of commercially important enzymes, retailoring of enzyme, large-scale industrial enzyme production and downstream processing: Case studies (from literature), improvement of enzymes.

Techniques of enzyme immobilization: Immobilization- definition, Immobilization techniques: physical and chemical adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with examples, Advantages and disadvantages of different immobilization techniques, Overview of applications of immobilized enzyme systems, Enzymes in electrodes.

Kinetics of immobilized enzymes: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors, Analysis of mass transfer effects of kinetics of immobilized enzyme reactions, Packed bed reactors, Film and pore diffusion effects on kinetics of immobilized enzyme reactions, Effectiveness factors of immobilized enzyme systems.

Application of enzymes: Industrial uses of enzymes, proteolytic enzymes in meat and leather industry, Clinical enzymology, Therapeutic enzymes, Diagnostic enzymes.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain mechanism and function of enzymes and assay enzyme reaction kinetics.
2. Produce, isolate and purify enzymes at lab/industry scale.
3. Design enzyme immobilization techniques based on the types of enzymes.
4. Comprehend and calculations involved in immobilized enzyme kinetics.
5. Explain the industrial applications of enzymes.

Text Books

1. Arora NK, Mishra J, Mishra V, Microbial Enzymes: Roles and Applications in Industries, Springer Singapore (2020).
2. Vogel A and May O (Ed.) Industrial Enzyme Applications, Wiley (2019).
3. Aehle, Enzyme in Industry: Production and Applications, Wiley-VCH (2007).

Reference Books

1. Bisswanger H, Enzyme Kinetics: Principles and Methods, Wiley-VCH (2017).
2. Dixon M and Webb MC, Enzymes, Longmans (1980).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include Assignments /Tutorials /Quizzes)	30

UBT802: NANOBIOTECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: This course introduces the concepts of quantum confinement, synthesis routes and characterization tools for nanomaterials to the students. It also provides preliminary ideas about choice of materials for biomedical, therapeutic and environmental applications.

Syllabus

Introduction to Nanoscience: Features of nanosystems, ccharacteristic length scales of materials and their influence on properties, quantum size effect: electron confinement in 2D, 1D and 0D, quantum nanostructures.

Synthesis and Characterization of Nanomaterials: Bottom-up and top-down approaches, thin film deposition techniques, biosynthesis of nanoparticles and self-assembly, **Characterization of nanomaterials:** X-ray diffraction, electron microscopy (SEM and TEM), atomic force microscopy and spectroscopy techniques (UV-visible, fluorescence, FTIR and RAMAN spectroscopy), Thermal characterization techniques (TGA, DTA, DSC).

Biomedical Applications: Concepts and working principles of Targeted drug delivery systems, photodynamic therapy, magnetic hyperthermia, nano-antimicrobials, nanobiosensors, etc.

Nanotoxicology: Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment (plants and microbes), impact of nanotechnology on society and industry.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain the effects of quantum confinement on physical, chemical and biological properties of materials at nanoscale
2. Choose an appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties
3. Choose appropriate nanostructures for biomedical applications
4. Evaluate the potential toxic effects of nanotechnology on living organisms

Text Books

1. “Introduction to Nanotechnology” Poole,C.P., Owens,F.J., John Wiley &Sons (2003).
2. "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", G. Cao, Imperial College Press (2004).
3. Nanobiotechnology; Concepts, Applications and Perspectives", C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004).
4. "Bionanotechnology: In Nanoscale Science and Technology", G. J. Leggett, R. A. L. Jones, John Wiley & Sons, (2005).
5. "Nano: The Essentials", T. Pradeep, Tata McGraw-Hill Publishing Company Ltd. (2007).

Reference Books

1. "Bionanotechnology", D. S. Goodsell, John Wiley & Sons (2004).
2. "Springer Handbook of Nanotechnology", Eds: Bhushan, 2nd edition.
3. "Encyclopedia of Nanoscience and Nanotechnology", Eds: H. S. Nalwa, American Scientific Publishers (2004).

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessional (May include assignments/tutorials/quizzes)	30

UBT832: CONCEPTS IN BIOMEDICAL INSTRUMENTATION

L	T	P	Cr
3	0	2	4.0

Course Objective: The course aims to develop an in-depth understanding of human body subsystems and to impart knowledge about cardiovascular and respiratory system measurements. In addition, the course will also provide understanding of measurement of biomedical processes and medical imaging.

Syllabus

Human Body Subsystems: Brief description of neuronal, Muscular, Cardiovascular and respiratory systems; Their electrical, Mechanical and Chemical activities.

Cardiovascular System Measurements: Electrocardiograph, ECG machines, vector cardiography (VCG), ballisto-cardiography (BCG), measurement of blood pressure, blood flow, cardiac output, cardiac rate, plethysmograph, pacemakers, defibrillators, Heart sounds, Phonocardiograph, Echocardiograph.

Respiratory System Measurements: Measurement of gas volume, respiratory transducers and instruments, respiratory therapy equipment, intermittent positive pressure breathing (IPPB) therapy, artificial mechanical ventilation, accessory devices used in respiratory therapy apparatus.

Measurement of Electrical Activity in Neuromuscular System and Brain: Neuron potential, muscle potential, electromyograph, brain potentials, electroencephalograph.

Analytical Instruments: pH measurement, measurement of pCO_2 & pO_2, calorimeter, blood cell counter, automation of chemical tests, oximeters.

Patient Care, Monitoring and Safety Measures: Elements of intensive care monitoring; Basic hospital systems and components Thermography, ultrasound imaging system, Physiological effect of electric currents, Safety measures; Standards, Codes and practices.

Prosthetics and Orthotics: Introduction to artificial kidney, Artificial heart, Heart lung machine, Limb prosthetics and Orthotics elements of audio and visual aids.

Computer Applications and Biotelemetry: Real time computer applications, Data acquisition and processing; Remote data recording and management.

Laboratory Work (if applicable):

Study of various physiological parameters using multichannel recorder, experiments based on stethoscope, sphygmomanometer, pulse oximeter, ECG, EMG. Respiratory parameters study using spirometer for lungs capacity, Ultrasonic characterization study of biological samples

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend the physiology of the heart, lung, blood circulation and respiration.
2. Apply different transducers and various sensing and measurement devices of electrical origin in biomedical applications.
3. Comprehend electrical safety in medical equipment's.
4. Explain different medical imaging techniques.

Text Books

1. Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.
2. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.

Reference Books

1. Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley InterScience (1989) 3rd ed.
2. Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd ed.
3. Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd ed.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes/performance)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT610: INDUSTRIAL BIOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To understand the use of living cells such as bacteria, yeast, algae or component of cells like enzymes, plants and animals to generate industrial products and processes. To study techniques for genetic improvement of micro-organisms to improve yield of bioproducts.

Syllabus

Introduction to Industrial Biotechnology: Overview of fermentation and other bioproducts Industries. Industrial Bioproducts and their producer organisms. Characteristic properties of Industrially important strains.

Strain improvement in industrial microorganisms: Improvement through mutation and recombination, Integrated Strain improvement program, targets for industrial strain improvement, Increase product concentration, Process improvement, biosynthesis of new metabolites. Precision Engineering Technology, biosynthetic technology.

Process technology for the industrial production of cell biomass, primary and secondary metabolites: SCP, Ethanol, Citric acid, Dextran and Amino acids. (Glutamic acid, L-Lysine.) SCP, beer and vinegar; bio preservatives (Nisin), cheese, biopolymers (xanthan gum, PHB, etc.).

Industrial Production: Vitamin (E, K, B_2 and B_{12}), antibiotics, microbial production of Bio pigments and flavours.

Production of enzymes and Biotransformation: Production of industrial enzymes (proteases, amylases, lipases, cellulases), whole cell biocatalysts, Applications of bioconversion, transformation of steroids and sterols; Microbially enhanced oil recovery (MEOR) and Bioleaching.

Laboratory Work (if applicable):

Isolation of amylolytic microorganisms; Production and partial purification of Amylase in shake flask culture, Production of Citric acid using Aspergillus species, Strain improvement of Aspergillus species using physical mutagenesis process; Strain improvement of Aspergillus species using chemical mutagenesis; Screening and isolation of cellulase producing enzymes; Determination of cellulolytic activity by DNS method; Screening microorganism for antibiotic production, Production and partial purification of Penicillin.

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend role of industrial biotechnology in improving microbial cells as factories.
2. Know the production aspects of commodity chemicals, pharmaceuticals and fine chemicals.
3. Apply knowledge of microorganisms in commercial production of flavours, fragrance, and microbial pigment in textile and industry.
4. Apply the process for commercial production of enzyme.
5. Know the process of Microbial Enhanced Oil Recovery and Microbial Leaching.

Text Books

1. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "Industrial Biotechnology: Products and Processes", John Wiley & Sons, 2016.
2. Waites, M.J., Morgan,N.L., Rockey,J.S., Higton, G., "Industrial Microbiology: An Introduction" Blackwell, 2001.
3. Cruger, W., Cruger, A., "A Textbook of Industrial Microbiology", Panima Publishing Corporation, 2nd Edition, 2005.

Reference Books

1. Pandey, A., Negi, S., Soccol, C.R., "Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products", Elsevier, 2016.
2. Okafor, N., "Modern Industrial Microbiology and Biotechnology", CRC Press, 2007
3. Presscott and Dunn's "Industrial Microbiology", CBS Publisher, 1987.
4. Casida Jr, L. E., "Industrial Microbiology", Wiley, 1968.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessional (May include Assignments/ Quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT512: STRUCTURAL BIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: Aiming to provide basic knowledge of structural components in biological systems, this course will make students aware of the lower to higher-order biological organizations, including the molecular to macromolecular structures and biological assemblies that drive the living systems.

Syllabus

Structural components of biological system: Levels of molecular organization, Brief discussions on: Amino acids (R groups and conformations, D- L- isomers), Nucleic acids (general characteristics of nucleic acid structures, forces and stabilizing geometries, glycosidic bond, rotational isomers), Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones; Basic forces and interaction holding biological structure (ionic, polar, hydrogen bonding; hydrophobic, etc.); symmetry in biological molecules: translation, rotation, reflection, and glide; organization of molecules in lattice.

Protein and DNA structures: Protein structure and hierarchy; secondary structure: α-helix, β sheet, loop; ϕ/ψ/χ angles: Ramachandran Plot; Super-secondary and tertiary structure: motifs, domain, and fold; Quaternary structure: oligomer assembly- protomer and oligomer: homo-oligomer and heterooligomer; biological implications of higher order protein structure - cooperative interactions, allosteric effects; structural families and classes; Structure of IgG, fibrous proteins (structure of collagen, keratin); Stabilizing ordered forms of DNA (A, B and Z), base-pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA); Concept of DNA lattice; Ribose puckering and tertiary structure of tRNA.

Biological membrane and higher order structural organization: Biological membrane components-lipids and membrane proteins; properties of biological membranes; Singer Nicolson model; Membrane protein structures, function, and assemblies; lipid rafts and micro-domains; Present understanding of the structure of biological membrane and cytoskeleton; Actin; Plant plasmodesmata structure; virus structures; SNARE complexes.

Tools for determination of biological structures: Overview of the major tools to study the molecular structures, X-ray diffraction; NMR and Electron microscopy; Atomic force microscopy (AFM).

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Explain the structural components of biological system.

2. Understand the aspects of protein and DNA structure and its importance in living system.
3. Comprehend the concept of lower to higher order structural organization of life.
4. Apply the basic methods of determining and studying biological structures.

Text Books

1. Alberts B, et al., *Molecular Biology of The Cell* 7th edition, Garland Science (2022).
2. Lodish et al., *Molecular Cell Biology* 8th edition, Freeman Macmillan (2016).

Reference Books

1. Branden CI, Tooze J: Introduction to Protein Structure, Garland Science (1998).
2. Williamson M: How Proteins Work, Garland Science (2012).
3. Miller and Tanner, Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules, Wiley, (2008).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT513: CELL AND TISSUE ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objective: This course will enable Students to understand thoroughly the key concepts of tissue organization, remodeling and strategies for restoration of tissue function. This will enable them to design tissue regeneration and tissue injury repair strategies.

Syllabus

Introduction: Basic definition, Introduction to tissue engineering, Cells as therapeutic agents with examples. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

Structural and organization of tissues: Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis. Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

Molecular and cellular aspects: Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signalling. Cell signalling molecules, growth factors, hormone and growth factor signalling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

Biomaterials and scaffold: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver, Bioreactors for Tissue Engineering.

Case study and regulatory issues: Case study of multiple approaches: cell transplantation and engineering for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend the structural organization of cells and tissues.
2. Understand the role of cell interaction, cell migration, wound healing and cellular processes.

3. Describe the different biomaterials and its properties, design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.
4. Comprehend applications of tissue engineering.

Text Books

1. Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick, Academic press, 4th edition (2014).
2. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press, 4th edition (2015).
3. Introduction to Biomedical Engineering, Endarle, Blanchard & Bronzino, Academic press, 3rd edition (2012).

Reference Books

1. Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC-Taylor & Francis, 1st edition (2016).
2. Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press, 1st edition (2008).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments /quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT514: NATURAL PRODUCTS

L	T	P	Cr
3	0	0	3.0

Course Objective: To study the drugs from a natural source, their specific method of isolation, stereochemistry, biological activity, and biogenesis/biosynthesis.

Syllabus

The general aspect of sources of medicinal plant products: Introduction to primary and secondary metabolites, types of secondary metabolites, production under stress, isolation of active constituent from plant material.

Alkaloids Definition, general properties, Classification, methods of isolation, stereochemistry, biological activity, general theory of biogenesis. Role of alkaloids in plants and their pharmaceutical importance.

Glycosides and saponins: Definition, Classification, general properties, medicinal importance, separation and isolation, structure determination, biological activity, the study of examples such as cardiac glycosides from Digitalis.

Steroids and triterpenoids: Definition, general properties, Classification, methods of isolation, biological activity, general theory of biogenesis, steroids from *Withania somnifera*, *Holarrhena* and *Solanum.*

Pigments: Occurrence, classification, introduction, and applications of carotenoids, xanthophylls, anthocyanins, flavones, flavonols. Acetate pathway and Shikimic acid pathway. Natural products of therapeutic importance from animals. Isolation, qualitative and quantitative analysis of secondary metabolite, Edible dyes, plant sweeteners, perfumery, and cosmetic agents.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Apply the acquire knowledge about the secondary metabolites, natural products in various therapies.
2. Design experiments for enhanced phytochemical production.
3. Design the process of natural products isolation and purification.
4. Will have a good understanding of biosynthetic pathways of natural products.

Text Books

1. Harborne, J. B. (2013) Phytochemical Methods, Second Edition, Springer publication.
2. K. G. Ramawat and J. M. Merillon (Eds.), 2010, Biotechnology – secondary metabolites, Oxford & IBH publishing Co. Pvt. Ltd.

Reference Books

1. S. V. Bhat, B. A. Nagasampagi and M. Sivakumar 2008. Chemistry of Natural Products, First Edition, Narosa Publishing House, New Delhi
2. V. P. Agrawal and V. P. Khamboj, (Eds.) Chemistry and biology of herbal medicine:
3. G. E. Trease and W. C. Evans, 2002, Pharmacognosy and Phytochemistry, 15th Edition, W.B. Saunders Edinburgh, New York.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT502: FOOD PROCESSING

L	T	P	Cr
3	0	0	3.0

Course Objective: To provide basic knowledge about food processing. To acquaint the students with the effects of processing and preservation techniques on physical, chemical and logical properties of food.

Syllabus

Thermal and cold processing: Thermal processing: classification of thermal processing methods, factors affecting thermal resistance of microorganisms and their spores, thermal death time, lethality concept. Refrigeration and cold storage, changes in food during refrigerated storage. Freezing and frozen storage, changes during freezing, freezing methods.

Food dehydration and concentration: Dehydration of foods**:** normal drying curve, change in food due to drying, drying methods and equipment. Food concentration, methods of concentration, changes in food due to concentration, intermediate moisture foods.

Food irradiation and microwave heating: Irradiation: mechanism of the killing of micro-organisms, factors affecting irradiation of foods, effect on the nutritional content of the foods. Microwave heating**:** working principle, components, food applications, effect on micro-organisms.

Other processing techniques: Smoking, preservatives (natural and artificial), antibiotics usage and side effects. Recent methods in food processing and preservation: pulse electric field, high pressure, ultrasound, ohmic and infrared heating.

Packaging and labelling of foods: Packaging material and their selection, types and levels of packaging, novel packaging techniques. MAP; applications for fresh-prepared produce oxygen, ethylene and CO_2 scavenging technology, zero energy chamber, hypobaric storage.

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend the working principle and mechanism of action of individual food processing methods on microorganisms and enzyme activity to the increase shelf life.
2. Apply various food processing and preservative techniques for shelf-life extension of foods.
3. Explain the principle and mechanism of processing food using ionic radiations and microwave radiations.
4. Compare the efficiency of different food processing and preservation techniques and know their pros and cons.
5. Identify different packaging materials used for food packaging and understand their importance.

Text Books

1. Norman N. Potter and Joseph H. Hotchkiss - Food Science, 5th ed. (2012)
2. M. Shafiur Rahman Handbook of Food Processing, 3rd Edition, CRC Press Taylor and Francis group (2020)
3. Frazier William C and Westhoff, Dennis C.)- Food Microbiology, TMH, New Delhi. (2017)
4. Mc Elhatton, Anna, do Amaral Sobral, Paulo José (Eds.) - Novel Technologies in Food Science, Vol.7, 2nd Edition, CRC Press Taylor and Francis group. (2012)

Reference Books

1. Avantina Sharma Textbook of Food Science & Technology (Vol-I & II), International Book Distributing Company, 3rd Ed. (2021)
2. Cheung, Peter C. K., Mehta, Bhavbhuti M. Handbook of Food Chemistry, Springer-Verlag Berlin Heidelberg, Ist Edition. (2015)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT624: MEDICAL BIOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To enlighten the knowledge of the students on different areas of Medical Biotechnology. To train the students in a hospital-based setup and familiarize them with the clinical diagnostics of diseases.

Syllabus

Introduction: History and scope of medical biotechnology, current status and future prospects.

Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.

Molecular basis of human diseases: Pathogenic mutations Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases.

Gene therapy: *Ex-vivo, In vivo, In situ* gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, ADA, AIDS, Cystic Fibrosis, Solid tumors.

Nucleic acid-based Therapy: Gene silencing technology, siRNA, Aptamers, antisense oligodeoxynucleotides (AS-ODN), Ribozymes, Peptide Nucleic Acids.

Recombinant & Immunotherapy: Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors, Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers.

Clinical management and Metabolic syndrome: PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism.

Course Learning Objectives (CLO)
The students will be able to:

1. Explain insights about genetic diseases and also about the molecular aspects related to human disease.
2. Gain new insights into molecular mechanisms of nucleic acid and gene therapy.
3. Gain knowledge about therapeutic recombinant proteins and immunotherapy for the treatment of different diseases.

Text Books

1. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000)
2. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl Amazon

Reference Books

1. Human Molecular Genetics by T. Strachan, Andrew Read Amazon Sales Rank.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT616: PROTEIN ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objective: Aiming to provide basic knowledge of engineering and design of the protein for its application, this course will make students learn structural and functional relationships in proteins and enabling students to improvise protein structure and function.

Syllabus

Elements of protein structure: Introduction to protein engineering; Primary structure: amino acids and their –R groups; Secondary structure: α helix, β strand, β sheet, loops, Ramachandran plot; Supersecondary and tertiary structure: motifs, domain, and fold; Quaternary structure: oligomer assembly; Relationship between structure and function: protein active site, catalytic site, crypto sites and druggability, cooperativity and allosteric effect.

Experimental and computational tools used in protein structural Biology: Protein structure determination by X ray diffraction (XRD) and NMR, Prediction of protein structure and conformation from sequence data (Homology Modeling, Threading and *de novo* prediction); Computational tools for prediction of protein active sites; Spectroscopy methods (CD and fluorescence) of determination of protein structural conformation; Protein activity and stability measurement (k_{cat}/K_m; T_m) using spectroscopy.

Protein Engineering: Mutagenesis methods: site directed mutagenesis–insertion, deletion, substitution, modular protein domain, random mutagenesis- directed evolution, gene shuffling; Kunkle mutagenesis; Phage display technology; Overview of CRISPR/Cas method (*in vivo*); Insertion of unnatural amino acids in protein using orthogonal system; Chemical modifications of proteins.

Protein expression and purification systems: Expression of proteins in bacteria, yeast, insect and mammalian cells; Protein purification overview; Different chromatography methods in protein purification (Affinity, ion exchange, gel exclusion, hydrophobic).

Application of Protein Engineering: Case study – protein engineering in lysozyme; Overview of protein design and considerations; Applications in drug delivery, biosensors, immunotherapy; antibody engineering.

Course Learning Objectives (CLO)
The students will be able to:

1. Understand the protein structure and function relationship.
2. Know the methods for determination of protein structure and studying protein structure, function and stability.
3. Apply the methods involved in protein engineering.
4. Design strategy of protein expression and purification.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

5. Comprehend the scope of protein engineering application.

Text Books

1. Primrose SB and Twyman RM: Principles of Gene Manipulation and Genomics Blackwell Publishing (2006).
2. Cleland JL and Craik CS: Protein Engineering: Principles and Practice, Wiley-Liss. (1996).
3. Lutz S and Bornscheuer U T: Protein Engineering Handbook, Wiley-VCH (2009).
4. Zhao H(Editor), Lee SY(Series Editor), Nielsen J(Series Editor), Stephanopoulos G (Series Editor): Protein Engineering: Tools and Applications, Wiley-VCH (2021).
5. Park SJ(Editor), Cochran JR(Editor), Protein Engineering and Design, CRC Press (2009).

Reference Books

1. Branden CI, Tooze J: Introduction to Protein Structure, Garland Science (1998).
2. Williamson M: How Proteins Work, Garland Science (2012).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT837: CANCER BIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to introduce current concepts and advances in the area of cancer biology. The students will understand the role of oncogenes and suppressor genes and get knowledge on cancer related mutagens and pathways and cancer therapy.

Syllabus

Fundamentals of cancer biology: Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumor suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer, cancer and chronic diseases.

Principles of carcinogenesis: Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis**.**

Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto-oncogene activity. Growth factors related to transformation. Telomerases.

Principles of cancer metastasis: Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumor cell invasion.

Cancer diagnostic and therapy: Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Different forms of therapy, chemotherapy, radiation therapy, chemotherapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend pathogenesis, molecular mechanisms,
2. Identify cancer related risk factors
3. Explain cancer metastasis microenvironment and cancer therapy
4. Understand cancer diagnostic and therapeutic

Text Books

1. Robert A. Weinberg. The Biology of Cancer. 2nd edition, 2006.
2. Robin Hesketh. Introduction to Cancer Biology Cambridge, University Press 2013.
3. David J. Kerr, Daniel G. Haller, Cornelis J.H. van de Velde, Michael Baumann. The Oxford Textbook of Oncology. 3rd edition, 2016.

Reference Books

1. An Introduction Top Cellular and Molecular Biology of Cancer", Oxford Medical Publications, 1991.
2. Stella Pelengaris and Michael Khan. The Molecular Biology of Cancer, 2nd edition. Wiley Blackwell, 2013

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT838: STEM CELL TECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to enable Students to understand the principles of stem cells. Students will acquire knowledge in the areas of tissue engineering.

Syllabus

Concept of Stem Cells: Stem cells: Basic concepts and properties, Totipotency, Pluripotency, Embryonic stem cells, Germinal stem cells, Adult stem cells, Tumor stem cells, Stem cell plasticity, General methods of characterization of stem cells.

Stem cell self-renewal and pluripotency: molecular mechanisms Cell cycle regulation in stem cells. Stem cell niches, Stem cell lineage tracing.

Embryonic stem (ES) cells: Isolation of ES cells, Salient features and application of ES cells, ES cells. Human and Mouse embryonic stem cells, Differentiation of ES cell, Maintenance of ES in undifferentiated state.

Hematopoietic Stem Cells (HSC): Identification and Characterization of HSCs, Sources of HSC Mouse Assay of HSC, HSC in leukemia and lymphoma, Clinical use of HSC.

Mesenchymal and Neural Stem Cell: Embryonic origin of MSC's, Harvesting, Isolation and Characterization, Differentiation studies of MSC's, Neural stem cell and Neural crest stem cell.

Stem Cells and Cloning: Therapeutic and reproductive cloning, Nuclear Transfer method, Application of NT ES cells, Safety of NT ES cells.

Application of stem Cells: Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia etc. Applications of stem cells in medicine and different disease models, Biosafety and Stem cell research, Regulatory considerations and FDA requirements for stem cell therapy.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend the concept of stem cells, different types of stem cells.

2. Describe the concept of stem cell cloning and its applications.
3. Recognize treatment of human diseases connected to stem cell therapy.

Text Books

1. Twyman RM, Developmental Biology Viva Books Pvt. Ltd. (2001
2. Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).
3. Lanza RP, Robert Langer R and Chick WL, Principles of Tissue Engineering, Academic Press (1997).

Reference Books

1. Palsson B and Bhatia S. Tissue Engineering, Pearson-Prentice Hall, (2003).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT839: DRUG DESIGN AND DEVELOPMENT

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to provide comprehensive knowledge of the basics of the drug discovery and development in the area of pharmacognosy and natural products; traditional and complementary medicine, synthetic medicinal chemistry and development of modern and innovative therapeutic substances.

Syllabus

Introduction: Definition of drugs, Overview of drug discovery process, Economics of drug discovery process, Trends in drug discovery process.

Rationale of Drug Discovery: Medical needs, Target identification, Target validation, Receptors and assay development.

Bio-resources for Small Molecule Discovery: Bioprospecting, Plant natural products, Microbial secondary metabolites, Marine natural products.

Screening Strategies for Drug Leads: Bioassay guided isolation, High throughput assays for antimicrobial, anticancer, anti-diabetic and anti-hypercholesterolemia, combinatorial chemogenomics, combinatorial chemistry. Characterization of drug molecules using integrated technology (TLC, HPLC, MS, IR, NMR).

Complementary and Alternative Medicine: Ayurveda and Herbal Drugs, Definition, Trade scenario, Pharmacopoeial status of herbal drugs.

Biosimilars: Introduction to biologics, defining biosimilars, differences between biosimilars and generics, selected examples of approved biosimilars, technical challenges associated with production of biosimilar molecules, regulatory aspects of biosimilar molecules. Current status of biosimilars in different countries (Europe, USA).

Drug Development and Pre-Clinical Studies: Introduction to structure–activity relationships (SAR), Drug receptor interactions; enzyme inhibition and inactivation, *In vitro* and *in vivo* pharmacodynamic models, Therapeutic index, Pharmacokinetics - Microbial and animal models, Lipinski's rule, *In vitro* and *in silico* toxicological models, Drug formulations.

Drug Regulatory Operations and Drug Manufacturing: Role of Regulatory Authorities, US FDA, Regulatory applications viz. investigational new drug (IND), new drug application (NDA), Abbreviated New Drug Application (ANDA).

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Demonstrate current approaches and steps of global drug discovery, their advantages and limitations.
2. Demonstrate awareness of different disciplines which play an integral role in drug discovery and development process.
3. Comprehend the key role played by natural products and pharmacognosy in shaping the pharmaceutical industry
4. Develop understanding of drug targets, their role in drug discovery process and their interaction with natural and synthetic ligands.
5. Demonstrate the importance of quality control and regulatory aspects of drug development processes and good manufacturing of medicines

Text Books

1. Benjamin B Basic Principles of Drug Discovery and Development, Academic Press, Ist Edition, ISBN : 9780124115088 (2015).
2. Larsen PK, Leljifore T and Medsan U, Text books of Drug Design and Discovery, CRC Press (2009) 4th ed.
3. Hillisch A and Hilgenfeld R, Modern Methods of Drug Discovery, Birkhauser (2003).

Reference Books

1. Patwardhan B, Drug Discovery and Development - Traditional Medicine and Ethnopharmacology, New India Publishing (2007).
2. Rick NG, Drugs from Discovery to Approval, 2nd Edition, Wiley- Blackwell (2009).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

UBT844: ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The course content aims to make the students understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or microbial technologies which can minimize the harmful impact of pollutants in the environment.

Syllabus

Introduction to Environmental Pollutants and Scope of Environmental Biotechnology: Water, soil and waste water their sources and effects. Application of biotechnology in environment protection

Biological Wastewater Treatment: Principles and Microbiology of wastewater treatment, unit operations: Aerobic process (Activated sludge, Oxidation ditches, Trickling filters, rotating discs, rotating drums, oxidation ponds). Anaerobic processes (Anaerobic filters, Up-flow anaerobic sludge blanket reactors), and other emerging biotechnological processes in waste water treatment for municipal, industrial wastewater

Solid Waste Management: Landfills, recycling and processing of organic residues, composting technologies, Biofuel production: Biogas, bioethanol, biohydrogen and biodiesel

Bioremediation and Biodegradation: Introduction and types of bioremediations, Microbial systems for heavy metal accumulation, Biosorption & detoxification mechanisms, Metal bioleaching and bio-oxidation In-situ and Ex-situ technologies, effect of chemical structure on biodegradation, recalcitrance, co-metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of xenobiotic compounds and hydrocarbons: long chain aliphatic, aromatic, halogenated, sulfonated compounds, surfactants, pesticides and oil spills.

Environmental Genetics: Plasmid borne metabolic activities, bioaugmentation, release of genetically engineered organisms in environment, Biosensor technology for monitoring pollutants.

Course Learning Objectives (CLO)
The students will be able to:

1. Comprehend environmental issues and role of biotechnology in the clean-up of contaminated environments.
2. Comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals.

3. Apply biotechnological processes in wastewater and solid waste management.
4. Comprehend biofuels/bioenergy systems; attributes for biofuel / bioenergy production.
5. Demonstrate innovative biotechnological interventions to combat environmental challenges.

Text Books

1. Rittmann, B. and McCarty, P., Environmental Biotechnology: Principles and Applications, McGraw-Hill (2006)
2. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.

Reference Books

1. Scargg, A., Environmental Biotechnology, Longman (1999).
2. Wainwright, M., An Introduction to Environmental Biotechnology, Kluwer Academic Press (1999).
3. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25-35
2	EST	35-45
3	Sessional (May include Assignments//Quizzes)	30

UBT845: MOLECULAR DIAGNOSTICS

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of the course is to make Students aware of the various medical diagnostic techniques and their use in diagnosing various disorders in humans.

Syllabus

Historical introduction: Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples. Interpretation of results. Normal microbial flora of the human body. Nosocomial infections. Host- Parasite relationships.

Microbial Pathogenicity: Pathogenicity and diagnosis of infection caused by *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio,* and *Mycobacterium.* Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis.

Pathogen Diagnostic techniques: Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study ofhelminthic diseases- *Fasciola hepatica* and *Ascaris lumbricoides*. Filariasis and Schistosomiasis.

Medical Genetics: Human Genome Project, Identifying human disease genes. Human disorders Biochemical disorders, Immune disorders, chromosomal disorders, single cell disorders and complex traits. Chromosomal disorder diagnosis autosomal; sex chromosomal; karyotype analysis. G-banding, in situ hybridization (FISH and on-FISH), and comparative genomic hybridization (CGH). Cancer cytogenetics Spectral karyotyping Genes in pedigree. Genetic Counselling.

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. Diagnosis using protein and enzyme markers, monoclonal antibodies. DNA/RNA based diagnosis Hepatitis, CML-bcr/abl, HIV - CD 4 receptor. Microarray technology- genomic and cDNA arrays, application to diseases.

Genetic disorders: Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders. Neonatal and Prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance.

Biochemical diagnostics: inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders.

Course Learning Objectives (CLO)
The students will be able to:

1. Receive insights about microbial diseases and its detection.
2. Gain new insights into medical genetics and pre-natal diagnosis.
3. Gain knowledge about different diagnostic procedures.

Text Books

1. Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications, Maribeth L. Flaws Ph.d , Lela Buckingham Publisher: F A Davis Co.
2. Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory Wayne W. Grody, Robert M. Nakamura, Frederick L. Kiechle, Charles Strom, Publisher: Academic Press; ASIN: B003FQM2OI.

Reference Books

1. Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
2. Parasitology (1997), Chatterjee K.D, Chatterjee Medical Publishers.
3. Bailey & Scott's Diagnostic Microbiology (2002), Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfel Ernest A. Trevino, Published by C.V. Mosby.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT846: COMPUTATIONAL BIOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To understand the basics of computational science and apply it to solve biological problems. To familiarize students with basic concepts of algorithms used in sequences, structural alignment, database searching, protein structure prediction, computer-based drug designing and machine learning classifiers for biological systems.

Syllabus

Introduction: Definition, Goals, applications of Computational Biology, Biological molecules such as DNA and Protein sequence, their structure and function. DNA and protein sequence databases. Structural databases

Basics of Computer Programming Problem solving Technique: Pseudocode, Algorithm, Flowchart, Data structures – Array, Stack, Queue, Linked, List concepts. Shell commands and scripting

Algorithms: Classification of algorithms, HMM profile searches, Algorithms to analyze system biology problems such as high throughput genomics and proteomics data, Machine-learning approaches, binary classification model development with examples in biological systems

Molecular computational biology: Gene prediction, sequencing genomes Protein structure determination by computational methods such as molecular modeling and molecular threading. Impact of the change of single amino acid (SNP) on the structure and function of the proteins, Protein-protein interactions, Functional insight by molecular dynamic simulations

Tutorials: Shell programming, Multiple sequence alignment, DNA binding motif finding by sequence alignment

Laboratory Work (if applicable)

Course Learning Objectives (CLO)
The students will be able to:

1. Perform programming Linux shell.
2. Explain various types of algorithms with their possible application in solving biological problems.
3. Explain the computational aspects of complex data analyses.

Text Books

1. Pevzner, P. A., Computational Molecular Biology, PHI Learning Pvt. Ltd, ISBN-978-81-203-2550-0.
2. Ghosh, Z. and Mallick, B., Bioinformatics Principles and Applications (2008) Oxford University Press ISBN 9780195692303.

Reference Books

1. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/ quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

UBT510: BIOLOGY FOR ENGINEERS

L	T	P	Cr
2	0	0	2.0

Course Objective: To learn about living world and basic functioning of biological systems. The course encompasses understanding of origin of life and some of its central characteristics. It also aims to familiarize engineering students to some of the intricate biological phenomena and mechanisms.

Syllabus

Introduction to the living world: Origin of life and chemical evolution, Properties of Life, levels of biological organization, Cells as unit of life, structure and functions of cell organelles.

Biomolecules and their applications: Brief introduction to the molecular constituents (Protein, carbohydrates, Lipids and nucleic acids) of living cells and their salient structural & functional attributes. DNA as information storage devices, DNA computing, DNA origami in synthesizing 2D and 3D structures, DNA fingerprinting, molecular scissors.

Energy and life: Law of energy transformation, free energy and metabolism, ATP generation, role of enzymes in metabolic reactions.

Nature inspired Biomaterial: Biomechanics, Biomimetics, Nanostructures in living world and their extraordinary properties, gecko foot, lotus leaf, turkey egg shell, mother of pearl, special properties of spider web and silk fibers, biosensors, smart implants, bionics, biosensors, medical diagnostics based on molecular recognition.

Computational aspects of bioinformatics: Sequence alignment, scoring matrices, algorithms used in sequence alignment, multiple sequence alignment and its applications.

Laboratory Work (if applicable)

Course Learning Objectives (CLO)

The students will be able to:

1. Explain the characteristic features of living-systems and differentiate them from non-living systems
2. Broaden the application of engineering knowledge of their branch by applying concepts of living systems.
3. Demonstrate familiarity with special properties of biological macromolecules
4. Upgrade their understanding about biological systems by drawing parallel with thermodynamics system and develop interface between an engineering specialization and living systems.
5. Design engineering products inspired by living creatures.

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.

6. Plan application of computational tools in bioinformatics.

Text Books

1. Nelson, DL and Cox MM., Lehninger: Principles of Biochemistry, WH Freeman (2008) 5th ed.
2. Campbell, NA, Reece, JB, Urry LA, Cain, ML, Wasserman, SA, Minorsky, PV and Jackson, RB, Biology – A global approach, Pearson Education Limited (10th edition).
3. Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2008).

Reference Books

1. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001).
2. Bruce Alberts et al., Essential cell biology, Garland Science (Taylor & Francis Group).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	25-35
2.	EST	35-45
3.	Sessionals (May include assignments/quizzes)	30

Approved in 109th meeting of the Senate held on March 16, 2023. Revised in 112th meeting of the Senate held on March 11, 2024.