



COURSE SCHEME

&

SYLLABUS

FOR

B.TECH.

BIO-TECHNOLOGY

2017

B.Tech Biotechnology (Revised Scheme w.e.f July 2017)
Bachelor of Technology Programme in Biotechnology

Programme Educational Objectives (PEOs):

- I. To prepare students for successful career in industry and research institutes.
- II. To develop the ability amongst the students to apply modern bioengineering techniques in industry and research.
- III. To enable students to work in a team with multidisciplinary approach.
- IV. To provide students with fundamental strength in analysing, designing and solving industry related problems.
- V. To promote and inculcate ethics and code of professional practice among students.

Programme Outcomes:

- I. After successful completion of Bachelors of Technology in Biotechnology, the students will be able to demonstrate basic knowledge in physical and biological sciences
- II. The students would acquire basic knowledge of engineering and skills to design and conduct experiments, analyse data and interpret the results.
- III. The students will be able to demonstrate understanding of basic knowledge in modern biology disciplines
- IV. The students will be able to demonstrate understanding of modern engineering techniques used in biotechnology
- V. The students will be able to acquire knowledge to apply engineering solutions in various industries
- VI. The student will be able to demonstrate ability to provide technological solutions in the fields of modern biotechnological applications
- VII. The students will be able to reinforce engineering skills and high end recent advances in biotechnology
- VIII. The students will be able to communicate effectively and demonstrate professional and ethical responsibilities
- IX. The graduates will acquire first-hand experience in working on projects at individual level and exposure to industrial and research environment.

COURSE STRUCTURE OF B. TECH. BIOTECHNOLOGY W.E.F JULY, 2017**FIRST SEMESTER 1ST YEAR**

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UPH004	APPLIED PHYSICS	3	1	2	4.5
2	UTA007	COMPUTER PROGRAMMING-I	3	0	2	4.0
3	UTA015	ENGINEERING DRAWING	2	4	0	4.0
4	UBT003	INTRODUCTION TO BIOTECHNOLOGY	2	0	0	2.0
5	UMA005	INTRODUCTORY MATHEMATICS-I	3	1	0	3.5
6	UHU003	PROFESSIONAL COMMUNICATION	2	0	2	3.0
		TOTAL	15	6	6	21.0

SECOND SEMESTER 1ST YEAR

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UCB008	APPLIED CHEMISTRY	3	1	2	4.5
2	UBT004	BIOCHEMISTRY-I	3	0	2	4.0
3	UBT005	CELL BIOLOGY AND GENETICS	3	0	2	4.0
4	UTA009	COMPUTER PROGRAMMING-II	3	0	2	4.0
5	UBT006	DEVELOPMENTAL BIOLOGY	3	0	0	3.0
6	UMA006	INTRODUCTORY MATHEMATICS-II	3	1	0	3.5
7	UBT301	MICROBIOLOGY	3	0	2	4.0
		TOTAL	21	2	10	27.0

THIRD SEMESTER 2ND YEAR

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT303	BIOCHEMISTRY II	3	0	2	4.0
2	UPH305	BIOPHYSICS	3	1	0	3.5
3	UBT302	FOOD SCIENCE	3	0	2	4.0
4	UBT504	IMMUNOTECHNOLOGY	3	0	2	4.0
5	UCH301	MATERIAL AND ENERGY BALANCE	3	1	0	3.5
6	UBT304	MOLECULAR BIOLOGY	3	1	2	4.5
		TOTAL	18	3	8	23.5

FOURTH SEMESTER 2ND YEAR

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT501	BIOANALYTICAL TECHNIQUES	3	0	2	4.0
2	UBT801	BIOSAFETY, BIOETHICS & IPR	2	1	0	2.5
3	UEN002	ENERGY AND ENVIRONMENT	3	0	0	3.0
4	UBT503	GENETIC & METABOLIC ENGINEERING	3	0	2	4.0
5	UBT404	INDUSTRIAL BIOTECHNOLOGY	3	0	2	4.0
6	UCH407	UNIT OPERATIONS	3	1	2	4.5
		TOTAL	17	2	8	22.0

FIFTH SEMESTER 3RD YEAR

S.No.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT601	ANIMAL BIOTECHNOLOGY	3	0	2	4.0
2	UBT602	BIOINFORMATICS & BIOSTATISTICS	3	0	2	4.0
3	UBT603	BIOPROCESS ENGINEERING	3	1	2	4.5
4	UBT605	PLANT BIOTECHNOLOGY	3	0	2	4.0
5	UBT508	TRANSDUCERS AND BIOSENSORS	3	1	2	4.5
6	UTA012	INNOVATION AND ENTREPRENEURSHIP*	1	0	2	4.5
7	UBT591	SUMMER TRAINING	-	-	-	4.0
		TOTAL	16	2	12	29.5

*5 self effort hrs

SIXTH SEMESTER 3RD YEAR

S.No	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UHU005	HUMANITIES FOR ENGINEERS	2	0	2	3.0
2	UBT606	DOWNSTREAM PROCESSING	3	1	2	4.5
3	UBT607	STEM CELL TECHNOLOGY	3	1	0	3.5
4	UBT608	FOOD PROCESSING	3	0	2	4.0
5	UBT609	MEDICAL BIOTECHNOLOGY	3	1	2	4.5
6	UBT604	PHARMACEUTICAL TECHNOLOGY	3	0	2	4.0
7		ELECTIVE-I	3	1	0	3.5
8		GENERIC ELECTIVE	3	0	0	3.0
		TOTAL	23	4	10	30.0

SEVENTH SEMESTER 4TH YEAR

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT793	PROJECT SEMESTER	-	-	-	20
		OR				
1	UBT794	PROJECT	-	-	-	13
2	UBT702	INDUSTRIAL WASTE MANAGEMENT	3	1	-	3.5
3	UBT704	TRENDS IN FOOD BIOTECHNOLOGY	3	1	-	3.5
		OR				
1	UBT795	START UP SEMESTER*	-	-	-	20
		TOTAL	-	-	-	20

*Based on hands on work on Innovation & Entrepreneurship

EIGHTH SEMESTER 4TH YEAR

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT802	NANOBIOTECHNOLOGY	3	1	0	3.5
2	UBT822	ENVIRONMENTAL BIOTECHNOLOGY	3	0	2	4.0
3	UBT832	CONCEPTS IN BIOMEDICAL INSTRUMENTATION	3	0	2	4.0
4		ELECTIVE-II	3	1	0	3.5
5		ELECTIVE-III	3	0	2	4.0
6	UBT891	CAPSTONE PROJECT	0	0	2	8.0
		TOTAL	15	2	8	27.0

ELECTIVE-I

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT621	COMPUTATIONAL BIOLOGY	3	1	0	3.5
2	UBT622	CELL AND TISSUE ENGINEERING	3	1	0	3.5
3	UBT623	PROTEIN ENGINEERING AND ENZYME TECHNOLOGY	3	1	0	3.5

ELECTIVE-II

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT834	BIOPROCESS EQUIPMENT DESIGN	3	1	0	3.5
2	UBT835	DRUG DESIGN AND DEVELOPMENT	3	1	0	3.5
3	UBT836	CANCER BIOLOGY AND INFECTIOUS DISEASES	3	1	0	3.5

ELECTIVE-III

S.NO.	COURSE NO.	COURSE NAME	L	T	P	CR.
1	UBT823	GENOMICS AND PROTEOMICS	3	0	2	4.0
2	UBT841	MOLECULAR DIAGNOSTICS	3	0	2	4.0
3	UBT842	ADVANCES IN FOOD TECHNOLOGY	3	0	2	4.0

GENERIC ELECTIVE

S.NO	CODE	TITLE	L	T	P	CR
1	UHU006	INTRODUCTORY COURSE IN FRENCH	3	0	0	3.0
2.	UCS001	INTRODUCTION TO CYBER SECURITY	3	0	0	3.0
3.	UHU007	EMPLOYABILITY DEVELOPMENT SKILLS	2	2	0	3.0
4.	UEN004	TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT	3	0	0	3.0
5.	UHU008	INTRODUCTION TO CORPORATE FINANCE	3	0	0	3.0
6.	UHU009	INTRODUCTION TO COGNITIVE SCIENCE	3	0	0	3.0
7.	UPH063	NANO SCIENCE AND NANO-MATERIALS	3	0	0	3.0
8	UMA066	GRAPH THEORY AND APPLICATIONS	3	0	0	3.0

TOTAL NUMBER OF CREDITS: 200.0

UMA001: 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.

Detail contents

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.

Course Learning Outcomes (CLO):

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).*

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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT003: INTRODUCTION TO BIOTECHNOLOGY

L	T	P	Cr
2	0	0	2

Course objective: To provide a foundation in biology with engineering of living systems and to apply various tools of traditional engineering fields such as mechanical, material, electrical and chemical to understand and solve biomedical and biological problems and harness potential of living systems for the benefit of human mankind.

Detail contents:

Introduction: Overview and scope of biotechnology, Integration of biology, medicine and engineering, across different levels of the biological hierarchy and basic knowledge with applications; Living systems and biomolecules, engineering tools in simulation studies, bioinformatics and nanotechnology, bioprocess and bio-separation engineering.

Application of Biotechnology: Biotechnologies: development, applications and their benefits: positive and negative impacts, basic principles of ethics concerning new technologies in agriculture, medicine, health care, diagnostics, food technology and environment.

Biotechnology product and design: Bioactive compounds, Single cell protein, Synthetic biology Bioethanol, Biodiesel, Bioreactors, Membrane based bioseparations, Biomolecular electronics, Biosensors, Tissue engineering and devices, Biocement.

Course Learning Outcomes (CLO):

Students will be able to

1. define biotechnology and list some basic applications.
2. apply systems engineering to living systems with applications across a wide domain of biological sciences.
3. explain process for particular technique in development of biotechnology product

Text books

1. *Smith J. E., Biotechnology, 3rd Edition, Cambridge University Press (2006)*
2. *Dhami, P.S., Srivastava, H.N. and Chopra, G., A Textbook of Biology, Pradeep Publications (2008).*

Reference Books

1. *Saltzman WM. Biomedical Engineering Bridging Medicine and Technology 2009 (ISBN-13: 9780521840996)*
2. *Starr, C., Evers C. A., Starr L. Concepts of Biology, First Edition, Cengage Learning India Pvt. Ltd. (2010)*
3. *Roberts, M. and Ingram, N. Biology, 2nd Edition, Nelson Thomas Ltd., UK (2001)*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include assignments/quizzes)	20

UTA008: ENGINEERING DRAWING

L	T	P	Cr
2	4	0	4.0

Course Objectives: This module is dedicated to graphics and includes two sections: manual drawing and AutoCAD. This course is aimed at to make the Students understand dimensioned projections, learn how to create two-dimensional images of objects using first and third angle orthographic projection as well as isometric, perspective and auxiliary projection, to interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism and to create and edit drawings using drafting software AutoCAD.

Engineering Drawing

1. Introduction
2. Orthographic Projection: First angle and third angle projection system
3. Isometric Projections
4. Auxiliary Projections
5. Perspective Projections
6. Introduction to Mechanical Drawing
7. Sketching engineering objects
8. Sections, dimensions and tolerances

AutoCAD

1. Management of screen menus commands
2. Introduction to drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: organizing and maintaining the integrity of drawings
6. Design of prototype drawings as templates.
7. Editing/modifying drawing entities: selection of objects, object snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to drawing

Micro Projects /Assignments:

1. Completing the views - Identification and drawing of missing lines in the projection of objects
2. Missing views – using two views to draw the projection of the object in the third view, primarily restricting to Elevation, Plan and Profile views
3. Projects related to orthographic and isometric projections
 - a. Using wax blocks or soap bars to develop three dimensional object from given orthographic projections
 - b. Using wax blocks or soap bars to develop three dimensional object, section it and color the section
 - c. Use of AUTOCAD as a complementary tool for drawing the projections of the objects created in (1) and (2).
4. Develop the lateral surface of different objects involving individual or a combination of solids like Prism, Cone, Pyramid, Cylinder, Sphere etc.

5. To draw the detailed and assembly drawings of simple engineering objects/systems with due sectioning (where ever required) along with bill of materials.
6. e.g. Rivet joints, simple bearing, wooden joints, Two plates connected with nut and bolt etc.

Course Learning Outcomes (CLO):

Upon completion of this module, Students will be able to:

1. creatively comprehend geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects.
3. interpret the meaning and intent of tolerance dimensions and geometric tolerance symbolism;
4. create the engineering drawings for simple engineering objects using AutoCAD
5. manage screen menus and commands using AutoCAD
6. operate data entry modes and define drawings geometrically in terms of Cartesian, polar and relative coordinates in AutoCAD
7. create and edit drawings making selections of objects, discriminating by layering and using entities, object snap modes, editing commands, angles and displacements using AutoCAD

Text books:

1. Jolhe, D.A., *Engineering Drawing*, Tata McGraw Hill, 2008
2. Davies, B. L., Yarwood, A., *Engineering Drawing and Computer Graphics*, Van Nostrand Reinhold (UK), 1986

Reference Books:

1. Gill, P.S., *Geometrical Drawings*, S.K. Kataria & Sons, Delhi (2008).
2. Gill, P.S., *Machine Drawings*, S.K. Kataria & Sons, Delhi (2013).
3. Mohan, K.R., *Engineering Graphics*, Dhanpat Rai Publishing Company (P) Ltd, Delhi (2002).
4. French, T. E., Vierck, C. J. and Foster, R. J., *Fundamental of Engineering Drawing & Graphics Technology*, McGraw Hill Book Company, New Delhi (1986).
5. Rowan, J. and Sidwell, E. H., *Graphics for Engineers*, Edward Arnold, London (1968).

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	Mid semester test (formal written test)	30
2	End semester test (formal written test)	45
3	Sessional: (may include the following) Continuous evaluation of drawing assignments in tutorial/ regular practice of AutoCAD tutorial exercises & Individual independent project work/drawing and AutoCAD assignment	25

UHU003 : Introduction to Professional Communication

L	T	P	Cr
2	-	2	3

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.

Detailed Contents:

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, proposals and papers.

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;Success strategies for Group discussions and Interviews.

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

Laboratory work :

1. Needs-assessment of spoken and written communication and feedback.
2. Training for Group Discussions through simulations and role plays.
3. Training for effective presentations.
4. Project based team presentations.
5. Proposals and papers-review and suggestions.

Minor Project (if any):Team projects on technical report writing and presentations.

Course learning outcome (CLO):

- 1.Understand and appreciate the need of communication training.
- 2.Use different strategies of effective communication.
- 3.Select the most appropriate mode of communication for a given situation.

4. Speak assertively and effectively.
5. Correspond effectively through different modes of written communication.
6. Write effective reports, proposals and papers.
7. Present himself/ herself professionally through effective resumes and interviews.

Text Books:

1. Lesikar R.V and Flatley 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:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	35
3.	Sessionals (Group Discussions; professional presentations; panel discussions; public speaking; projects, quizzes)	40

UPH004: APPLIED PHYSICS

L T P Cr

3 1 2 4.5

Course Objectives: Introduce the laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. Students will learn measurement principles and their applications in investigating physical phenomenon.

Oscillations and Waves: Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; **Acoustics:** Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera; **Ultrasonics:** Production and Detection of Ultrasonic waves, Applications - green energy, sound signalling, dispersion of fog, remote sensing, Car's airbag sensor.

Electromagnetic Waves: Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth.

Optics: Interference: Parallel and wedge-shape thin films, Newton rings, Applications as Non-reflecting coatings, Measurement of wavelength and refractive index. **Diffraction:** Single and Double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers. **Polarization:** Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows. **Lasers:** Basic concepts, Laser properties, Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment.

Quantum Mechanics: Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunnelling effect (Qualitative idea), Application - Quantum computing.

Laboratory Work:

- 1 Determination of damping effect on oscillatory motion due to various media.
- 2 Determination of velocity of ultrasonic waves in liquids by stationary wave method.
- 3 Determination of wavelength of sodium light using Newton's rings method.
- 4 Determination of dispersive power of Sodium-D lines using diffraction grating.
- 5 Determination of specific rotation of cane sugar solution.
- 6 Study and proof of Malus' law in polarization.
- 7 Determination of beam divergence and beam intensity of a given laser.
- 8 Determination of displacement and conducting currents through a dielectric.
- 9 Determination of Planck's constant.

Micro Project: Students will be asked to solve physics based problems/assignments analytically or using computer simulations, etc.

Course Learning Outcomes (CLO):

Upon completion of this course, Students will be able to:

1. demonstrate a detailed knowledge of oscillations, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics;
2. discuss how the laws of physics have been exploited and applied in the development and design of simple engineering systems;
3. collate, analyse and formulate an experimental report with error analysis and conclusions;

Text books:

1. *Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001).*
2. *Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007).*
3. *Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999).*

Reference Books:

1. *Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice Hall™ (2008).*
2. *Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990).*
3. *Verma, N.K., Physics for Engineers, Prentice Hall of India (2014).*

Evaluation Scheme:

EVENT	SUB EVENT	MARKS	WEITAGE
MID SEMESTER TEST	-	25	25
SESSIONAL TESTS	QUIZ	6	6
	TUTE TEST	4	4
	LABORATORY WORK EVALUATION	20	20
	MICRO-PROJECT	10	10
END SEMESTER TEST	-	100	35
TOTAL			100

UTA007: COMPUTER PROGRAMMING – I

L	T	P	Cr
3	0	2	4.0

Course Objective: This course is designed to explore computing and to show Students the art of computer programming. Students will learn some of the design principles for writing good programs.

Introduction to ‘C++’ programming: Fundamentals, Structure of a C++ program, Compilation and linking processes.

Expressions and Console I/O: Basic Data types, Identifier Names, Variables, Scope, Type qualifiers, Storage class specifier, Constants, Operators, Reading and writing characters, Reading and writing strings, Formatted and console I/O, cin(), cout(), Suppressing input.

Statements: True and False, Selection statements, Iteration statements, Jump statements, Expression statements, Block statements.

Arrays and Strings: Single dimension array, two-dimension array, Strings, Array of strings, Multi-dimension array, Array initialization, Variable length arrays.

Structures, Unions, Enumerations, and Typedef: Structures, Array of structures, passing structures to functions, Structure pointers, Arrays and structures within structures, Unions, Bit-fields, Enumerations, typedef.

Introduction to Object Oriented Programming with C++: Objects and Classes, basic concepts of OOPs (Abstraction, Encapsulation, Inheritance, Polymorphism), Constructors/Destructor, Copy constructor, Dynamic Constructor, Overloading (Function and Operator).

Pointers: Pointer variables, Pointer operators, Pointer expressions, Pointers and arrays, multiple indirection, Pointer initialization, Pointers to arrays, dynamically allocated arrays, Problems with pointers, Pointers and classes, pointer to an object, this pointer.

Functions: General form of a function, understanding scope of a function, Function arguments, Command line arguments, Return statement, Recursion, Function prototype, Pointers to functions, Friend function and class.

Pre-processor and Comments: Pre-processor, #define, #error, #include, Conditional compilation directives, #undef, Single line and multiple line comments.

File I/O: Streams and files, File system basics, fread() and fwrite(), fseek() and random access I/O, fprintf() and fscanf(), Standard streams.

Laboratory work: To implement Programs for various kinds of programming constructs in C++ Language.

Course Learning Outcomes (CLO):

On completion of this course, the Students will be able to

1. write, compile and debug programs in C++ language.
2. use different data types, operators and console I/O function in a computer program.
3. design programs involving decision control statements, loop control statements and case control structures.
4. understand the implementation of arrays, pointers and functions and apply the dynamics of memory by the use of pointers.

5. comprehend the concepts of structures and classes: declaration, initialization and implementation.
6. apply basics of object oriented programming, polymorphism and inheritance.
7. use the file operations, character I/O, string I/O, file pointers, pre-processor directives and create/update basic data files.

Text books:

1. Kanetkar Y., *Let Us C++*, BPB Publications, 2nded.
2. Balaguruswamy E., *Object Oriented Programming with C++*, McGraw Hill, 2013.

Reference Books:

1. Brian W. Kernighan, Dennis M. Ritchie, *The C++ Programming Language*, Prentice Hall)
2. Schildt H., *C++: The Complete Reference*, Tata Mcgraw Hill, 2003.

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	20
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

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

Detail contents:

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).

Course Learning Outcomes (CLO):

Students will be able

- 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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

Course Objective: Understand fundamentals of object oriented programming in java. To help students understand fundamentals of programming such as variables, conditional and iterative execution, methods, etc.

Introduction to Java: History and evolution of Java, Java vs other popular languages, Java programming environment, fundamental of Java programming language, primitive data types and variables, floating point types, literals, variables, type conversion and casting, arrays, arithmetic operators, bit wise operators, relational, Boolean expressions, statements and blocks, control flow statements selection, iteration and jump statements.

Object Oriented Programming Concepts in Java: Objects and classes, declaring objects, constructors, this keyword, method overloading and constructor overloading, nested classes.

Inheritance and Exception Handling: Defining, applying and implementing interfaces; method overriding, super and final keywords, polymorphism, generics, defining, finding and importing packages, exceptions handling with try, catch, throw, throws and finally keywords, wrapper classes.

I/O and Threads: Binary I/O, file handling, communication with internet, thread model, creating a thread, synchronization, inter thread communication, thread lifecycle.

Building GUI in Java: Introductions to Applets, Building Java GUIs Using the Swing API, Describe the JFC Swing technology, identify the Swing packages, Describe the GUI building blocks: containers, components, and layout managers, Examine top-level, general-purpose, and special-purpose properties of container, Examine components, Examine layout managers, describe the Swing single-threaded model,

painting, using images, performing animations, borders, icons, Introduction to Event handling, implementation of Listeners for event handling.

Laboratory Work:

Main focus is on implementing basic concepts of object oriented programming and to enhance programming skills to solve specific problems.

Course Learning Outcomes (CLO):

On completion of this course, the students will be able to:

1. comprehend the concepts of Object Oriented Computing in Java.
2. implement decision statements and looping statements.
3. grasp the concepts of input and output handling from console, files and internet in Java.
4. create frames, windows, containers, GUI components in Java and handle events for building GUI.
5. develop GUI applications

Text Books:

1. Deitel H. and Deitel P., *JAVA - How to Program*, Pearson Education (2003).
2. Hortsman CS., Cornell G., *Core Java Volume I-Fundamentals*, Prentice Hall, (2012).

Reference Books:

1. Naughton P., Schildt H., *JAVA2 – The Complete Reference*, Tata McGraw Hill (2002).

Evaluation Scheme:

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

UBT004: BIOCHEMISTRY-I

L	T	P	Cr
3	0	2	4.0

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.

Detail contents:

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- proteinogenic amino acids; 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: Preparation of buffer solutions, Determination of pK values, Estimation of reducing sugars, total carbohydrates, amino acids and proteins, Quantitative analysis of lipids, Enzyme assays from microbes and eukaryotes, Basic strategies for enzyme purification, Enzyme kinetics i.e determination of K_m and V_{max} of enzymes.

Course Learning Outcomes (CLO):

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, J.L., 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	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT005: CELL BIOLOGY AND GENETICS

L	T	P	Cr
3	1	0	4.0

Course objectives: 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.

Detail contents:

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, cytoskeleton, transport across cell membrane, different types of transporters and their functional significance.

Cell division: mitosis and the phases of cell division, meiosis, cell cycle regulation, significance of cell cycle regulation in repair pathways and cancer, apoptosis, intracellular trafficking, signal transduction pathways

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

Linkage and recombination: Recombination and crossing over, linkage maps, chromosomal mutations – deletion, deficiency, insertion, inversion and translocation, mapping of genes, Hardy-Weinberg distribution, genetic disorders in humans

Laboratory Work: Microscopic examination of bacterial, plant and animal cells, study of different stages of mitosis, Numerical problems based on genetic crosses, chi-square test, Hardy-Weinberg distribution.

Course Learning Outcomes (CLO):

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

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)

Evaluation Scheme

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

Course objective: The course is aimed to make Students understand the different phases of the embryo development and associated medical implications.

Detail contents:

Introduction: History, Principles of development-life cycles, Developmental patterns and evolution of differentiation, Experimental embryology, Role of genes in development, Amniocentesis.

Early Embryonic Development: Gametogenesis- Spermatogenesis and oogenesis, Types of eggs, Fertilization- changes in gametes, mono- and polyspermy; The early development of *Caenorhabditis elegans*; The early development of Xenopus-cleavage, Gastrulation, Embryonic induction and organizers; The early development of chick-cleavage, Gastrulation.

Later Embryonic Development: Differentiation of germ layers-Formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments), Extraembryonic membranes in birds and human, Implantation of embryo, Placentation – structure, types and physiology of placenta.

Post-Embryonic Development: Metamorphosis- changes and hormonal regulation of metamorphosis in insects and amphibians, Regeneration- modes of regeneration-epimorphosis, Morphogenesis and Regeneration, Ageing-concepts and model (*Caenorhabditis elegans*).

Implications of Developmental Biology: Medical implications: Infertility–Diagnosing Infertility, IVF, Teratogenesis – teratogenic agents and effect of teratogens on embryonic development.

Course learning outcomes (CLO):

Students will be able to

1. analyze and interpret the principles of early and late embryonic development
2. compare and comprehend the development of model organisms like *C. elegans*, amphibians, Aves
3. demonstrate medical implications of developmental biology

Text books

1. *Developmental Biology*, Gilbert, Sinauer Associates Inc. Massachusetts, USA. (8th Ed., 2006)
2. *Principles of Development*, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, Oxford University Press, New Delhi, INDIA. (3rd Ed., 2006)
3. *Analysis of Biological Development*, Kalthoff, McGraw-Hill Science, New Delhi, INDIA. (2nd Ed., 2000)

Reference Books

1. Kalthoff, *Analysis of Biological Development, II Edition*, McGraw-Hill Professional (2000).
2. Verma, P.S., V.K. Agarwal and Tyagi, 1995. *Chordate embryology*, S. Chand & Co., New Delhi.
3. Majumdar, N.N *Text books of vertebrate embryology*. Tata Mc-Graw-Hill Publishing Company Ltd, New Delhi. 1990.

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include assignments/quizzes)	20

UCB008: APPLIED CHEMISTRY

L T P Cr

3 1 2 4.5

Course Objective: The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials and analytical techniques.

Atomic Structure and Bonding: Chemical change; elements, compounds and mixtures, Atomic structure, dual nature of electron, concept of atomic orbitals, Pauli's Exclusion principle, Concept of chemical bonding: covalent, ionic, metallic, hydrogen bond, Vander Waal's, Hybridization and shapes of molecule, electronic structure and periodic table.

Chemical Equilibrium: Law of mass action, Factors that influence the position of equilibrium. Ionic equilibria: ionic equilibria in aqueous solutions; strong and weak acids and bases; buffer solution and indicators.

Electrochemistry: Migration of ions, Transference number, Specific, equivalent and molar Conductivity of electrolytic solutions, Conductometric titrations, Electrode potential and types of electrodes, Introduction to galvanic and concentration cells, Liquid junction potential.

Colligative Properties of Dilute Solutions: Depression of freezing point and elevation of boiling point.

Phase Rule: States of matter, Phase, Component and Degree of freedom, Gibbs phase rule, One component and two component systems.

Water Treatment and Analysis: Hardness and alkalinity of water: Units and determination, External and internal method of Softening of water: Lime-soda Process, Ion exchange process, Desalination of brackish water.

Fuels: Classification of fuels, Calorific value, Cetane and Octane number, fuel quality, Comparison of solid liquid and gaseous fuel, properties of fuel, alternative fuels: biofuels, Power alcohol, synthetic petrol.

Application of Atomic and Molecular Spectroscopic Methods: Structure determination of certain model compounds of industrial importance.

Assignments based on working and applications of advanced instruments will be given in the tutorial class.

Laboratory Work:

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer.

Acid and Bases: Determination of mixture of bases

Spectroscopic techniques: Colorimeter, UV-Vis spectrophotometer.

Kinetics: Kinetics of oxidation of iodine ion by peroxydisulphate ion.

Thermochemistry: Cloud point and pour point determination

Water and its treatment: Determination of hardness, alkalinity, chloride, chromium, iron and copper in aqueous medium.

Course Learning Outcomes (CLO):

The Students will be able to:

1. analyse trends in periodic table with electronic and atomic structure.
2. interpret phase diagrams of pure and binary substances.
3. demonstrate the working of electrodes and their applications.
4. calculate various parameters defining water and fuel quality
5. identify the various functional groups through IR spectra.
6. carry out basic experimental procedure and to emphasize need for safety and safety procedure in laboratory.

Text books:

1. Ramesh, S. and Vairam S. *Engineering Chemistry*, Wiley India (2012).
2. Jain, P.C. and Jain, M. *Engineering Chemistry*, Dhanpat Rai Publishing Co. (2005).
3. Puri, B.R., Sharma and L.R., Pathania, M.S. *Principles of Physical Chemistry*, Vishal Publishing Co. (2008).

Reference Books:

1. Brown, Holme, *Chemistry for engineering Students*, Thompson.
2. Shulz, M.J. *Engineering Chemistry*, Cengage Learnings, (2007).

Evaluation Scheme:

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

UBT301: MICROBIOLOGY

L	T	P	Cr
3	0	2	4.0

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.

Detail contents:

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.

Laboratory Work: Microscopic examination of stained cell preparation, Gram staining and staining of spore, capsule, Sterilization techniques, Preparation of culture media, sources of microbial contamination, techniques for isolation of pure cultures, isolation of heterotrophs and autotrophs, isolation and enumeration of microbial population in soil and water, microscopic measurement of cell dimension and growth by cell counting, biochemical activity of bacteria, bacterial growth curve.

Course Learning Outcomes (CLO):

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*, McGraw Hill (2003) 5th ed.
2. Stanier, R.Y., Ingraham, J.L. and Wheelis, M.L., *General Microbiology*, MacMillan (2007) 5th ed.

Reference Books

1. Tortora, G.J., Funke, B.R., and Case, C.L., *Microbiology- An Introduction*, Pearson Education (2007) 8th ed.

Evaluation Scheme:

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

UCH301: MATERIAL AND ENERGY BALANCE

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.

Detail contents

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.

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 Outcomes (CLO):

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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT302: FOOD SCIENCE

L	T	P	Cr
3	0	2	4.0

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

Detail contents:

Basic concepts of food science: Food, its terminology and its application in various areas like engineering, chemistry and nutrition. Food classification on the basis of origin, functions. Food groups and their classification (basic four, five, seven and pyramid). Concept of balanced diet, malnutrition, recommended dietary allowances (RDAs) for various age groups according to their physiological status for specific nutrients and energy. Diet Planning.

Food Composition: Nutrients and their classification (Macronutrients and micro-nutrients). Carbohydrates, Proteins, Fats (Macronutrients) and Vitamins & Minerals (micro-nutrients) their classification, structure, chemical & functional properties, food sources and deficiency diseases. Bioactive components (Anti-nutritional factors), enzymes, natural pigments etc. in food their role and importance in processing and food consumption.

Food microbiology: Characteristics of useful micro-organisms in food (Bacteria, yeast, fungi and moulds), Microbial growth in food (important factors). Food spoilage by micro-organisms, factors responsible for spoilage and minimum growth of micro-organism in a food. Food borne illness (infection and intoxication). Classification of foods on the basis of spoilage. Spoilage micro-organisms for every (five) food group and for fermentation / production of useful products. Pathogenic micro-organisms and their treatment in food. Traditional processing methods: different cooking, smoking, baking, frying etc. methods and types with advantages and disadvantages. Food spoilage and principles of preservation in correlation to increase the shelf life.

Food safety Laws and Standards: Food quality & analysis: Pre and Post-harvest factors in food quality, Physical, Chemical and Microbiological factors of quality, proximate analysis of foods, Sample and sample preparation in foods. Food laws: Voluntary and Mandatory food laws in India. Food Certification Agencies.

Impetus in Food Industry: New Product Development, strategies, planning for marketing, Process designing of food. Different metals used in cooking of food from traditional to plastic and storage of food with advantages and disadvantages. Foods types available in the market need of their innovation, advantages and disadvantages.

Laboratory work: Understanding the RDA's and their importance in diet planning. Application of principles of preservation to reduce the spoilage in foods. Labels on the different food packages and their understanding. Estimating the Physico-chemical composition of foods (moisture, fat, protein, ash, total solids, TSS etc.). Identifying the microbial flora of different raw foods and finished ones. Process designing of food. Objective and Subjective quality evaluation of food. Food laws and their specification on the basis of each food group. Experiment in cooking metals used with cooking and storage of food with microbial load analysis.

Course Learning Outcomes (CLO):

Students will be able to

1. explain importance of different types of food 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. apply traditional methods for food preservation in developing a new food product.
5. determine food quality by food analysis as per food laws and their importance in food industry.

Textbooks

1. *Vaclavik, Vickie, Christian, Elizabeth W - Essentials of Food Science (2008)*
2. *Geoffrey Campbell-Platt - Food Science and Technology, Wiley-Blackwell Publisher. (2009)*
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 William C and Westhoff, Dennis C. Food Microbiology, TMH, New Delhi (2004)*
7. *B. Sivasankar, Food Preservation, PHI Learning. (2002)*

Reference Books

1. *S. Suzanne Nielsen-Food Analysis:Food Science Texts Series, Springer; 3rd ed. Edition (2003)*
2. *Avantina Sharma Textbook of Food Science & Technology (Vol - I & II), International Book Distributing Company, 2nd ed. (2010)*
3. *Srinivasan Damodaran- Fennema's Food Chemistry, Fourth Edition (Food Science and Technology, CRC Press; 4 edition (2007)*

Evaluation Scheme:

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

UBT504: IMMUNOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to provide Students with detail understanding of different cells of the immune system and their role in immune protection as well as application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of cancer, autoimmune disease, AIDS and different infectious diseases.

Detail contents:

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: Factors responsible for immunogenicity, Epitopes, Adjuvants, Super-antigens, 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, Immuno-electrophoresis, RIA, ELISA, ELISPOT assay, Western blotting, Immunofluorescence and Flow cytometry.

Autoimmunity, Hypersensitivity and Immunodeficiency: Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Primary and secondary immunodeficiency, AIDS

Immune response to Infectious disease, Cancer and Transplantation: Immune response to viral infections, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection, Immunodiagnostics (diagnosis of infectious diseases)

Vaccine: Active and passive immunization, Vaccine types (Live but attenuated, Killed, Subunit, Recombinant, DNA and Peptide).

Laboratory work: Blood film preparation and identification of cells, Immuno-diffusion, Hemagglutination, Agglutination inhibition, Rocket immune-electrophoresis, Western blotting, ELISA, Epitope prediction using Immuno-informatics tool, Isolation of Peripheral blood mononuclear cells

Course Learning Outcomes (CLO):

Students will be able to

1. explain the role of immune cells and their mechanism in body defense mechanism.
2. apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. demonstrate immunological techniques.
4. interpret association of immune system with cancer, autoimmunity, transplantation and infectious disease.
5. generate new vaccine target and develop strategy to design novel vaccine.

Text books

1. Janeway C. A. Travers P., Walport M., *Immuno biology: the immune system in health and disease*, Garland Science Publishing New York (2012) 8th ed.
2. Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- *Immunology* W.H. Freeman & Company (2013), 7th ed.

Reference Books

1. *Delves P. J., Martin J. S., Burton R. D., Roitt M. I. Roitt's Essential Immunology, Wiley Blackwell (2011) 12th ed.*
2. *Khan F.H. The Elements of Immunology, Pearson Education (2009)*

Evaluation Scheme:

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

UBT303 : BIOCHEMISTRY-II

L	T	P	Cr
3	0	2	4.0

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

Detail Contents:

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.

Laboratory Work: Separation and identification of amino acids, polar and non-polar lipids by chromatographic techniques, Iodine number of oil, Estimation of cellular and serum proteins, Estimation of inorganic and organic phosphorus, Quantification of nucleic acids, Estimation of lactic acid and cholesterol in serum, Subcellular fractionation and assay of the marker enzymes, Effects of pH and temperature on the activity of β -galactosidase, Glucose oxidase, Glucose-6-phosphatase, Serum alkaline phosphatase, Glutamate dehydrogenase Lactate dehydrogenase, Isolation of photosynthetic pigments

Course Learning Outcomes (CLO):

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.

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	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT304: MOLECULAR BIOLOGY

L	T	P	Cr
3	1	2	4.5

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.

Detail contents:

Storage and replication of genetic information: chromosomal structure and organization, nucleic acids, transformation, conjugation, and transduction. 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 phages, viruses, prokaryotes and eukaryotes, regulatory elements such as operators, UAS, PRE, NRE, enhancers, insulators and trans-factors such as activators, repressors, trans-factors, general and tissue specific transcription factors.

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, RNA interference, antisense RNA, oncogenes, proto-oncogenes and tumour suppressor genes, apoptosis, molecular biology of genetic and metabolic disorders, aging and senescence.

Laboratory Work: Genomic DNA isolation from plant and animal cells, RNA isolation, whole cell protein isolation and analysis on SDS-PAGE, DNA, RNA and protein quantification by spectrophotometric analysis, restriction mapping and analysis on native-PAGE, studies on gene regulation, induction of gene.

Course Learning Outcomes (CLO):

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. explain mechanisms involved in gene expression.
4. explain molecular basis of complex metabolic diseases.

Text books

1. Lewin, B., *Genes VIII, International Edition, Pearson Education International (2004), ISBN 0131238264*
2. Pal, J. K. and Ghaskadbi, S. S., *Fundamentals of Molecular Biology, Oxford University Press, ISBN-13: 978-0-19-569781-0*

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

Evaluation Scheme:

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

Course Objective: Introduce the Students to the fundamental concepts of physics applicable in biological systems.

Detail contents

Introduction: Life and its physical basis, length force and time scales in living systems, chemical bonding and stability of molecules, forces and energies at nanometer scale: Intermolecular interactions, electrostatic screening, chemical composition of living systems.

Thermodynamics and entropy in biology: Heat, temperature, chemical equilibrium, thermodynamic equilibrium, types of energies and laws of thermodynamics, Applications: Brownian motion, chemical kinetics and catalysis, protein folding and unfolding, metabolism in animals. Entropy, Entropic forces, Applications: Electrostatics in water, melting of DNA, phase transitions in membranes, Diffusion and its applications in biological systems.

Statistics and probability: Discrete and continuous distributions and their mean and variance, Normal and Gaussian distributions, Boltzmann Distribution, Self-assembly, Applications: decoding of the ideal gas law, heredity, Activation barriers and reaction rates.

Transport at low Reynold numbers: Friction in fluids, Reynold number, significance of low Reynolds numbers, The time reversal properties of a dynamical law, Applications: Swimming and pumping - Bacterial motion, vascular networks.

Molecular motors and nerve impulses: Electro-osmotic effects, ion pumping, mitochondria, nerve impulses and their electrical network equivalence, mechanism of the action potential, Applications: synapses in nerves and muscles, neuromuscular junctions.

Course Learning Outcomes (CLO):

Students will be able to

1. evaluate appropriate physical scale (length, force, time, energy, etc.) that is applicable in living systems.
2. apply laws of thermodynamics in biological processes like protein folding, metabolism, DNA melting, phase transitions in membrane, etc.
3. apply discrete and continuous distributions in biological systems.
4. explain the significance of low Reynold numbers in biological systems and their role in transport phenomenon in living systems.
5. draw electrical network equivalence of nerve signals.

Text books

1. P. Nelson, *Biological Physics: Energy, information, life, Freeman, 1st edition (2013)*
2. Rodney M.J. Cotterill, *Biophysics: An Introduction, Wiley, 1st Edition (2002)*

Reference Books

1. R. Glaser, *Biophysics: An introduction, Springer, 2nd Edition (2012)*
2. Mae-Wan Ho, *The rainbow and the worm: The physics of organisms, World scientific publishing, 3rd edition (2008)*

Evaluation Scheme:

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

UBT501 : BIOANALYTICAL TECHNIQUES

L T P Cr

3 0 2 4.0

Course Objectives: The objectives of this course is 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.

Detail contents

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: Paper chromatography, thin layer chromatography, column chromatography, gas chromatography, centrifugation, UV visible spectroscopy, SDS-PAGE and agarose gel electrophoresis microscopy and micrometry, microtomy, identification of blood group

Course Learning Outcomes (CLO):

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 (2006) 6th edition*
2. *Pingoud A., Urbanke C., et la. 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	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UCH407: UNIT OPERATIONS

L	T	P	Cr
3	1	2	4.5

Course Objective: To introduce Students with fundamentals concerning the calculations and principles involved in basic unit operations in biotechnology processes.

Detail contents:

Introduction: Physical variables, Units, their dimensions and conversions, dimensional consistency, dimensionless ratios, precision of measurement, unit operation involved in biotechnological processes (general process flow sheet)

Fluid Characteristics and Dynamics

Definition and classification of fluids, types of fluid, types of flow, Flow through pipes: laminar flow, Turbulent flow, Hagen Poiseuille equation, Power law, Energy losses, Pipe networking, Flow measuring devices, Pumps

Mass Transfer

Modes of mass transfer, Fick's law of diffusion, diffusion theory, analogy between heat, mass and momentum transfer, interphase mass transfer, overall mass transfer coefficient, mass transfer in equipments, humidification and dehumidification, role of diffusion in mass transfer, oxygen uptake in cell culture, factors affecting cellular oxygen demand, oxygen transfer from gas bubble to cell.

Heat Transfer

Heat conduction, Heat conduction in composite wall structure, thick walled tube, sphere, insulation, unsteady state condition, Natural and forced convection, heat transfer in laminar and turbulent flows inside tubes, condensation, design of heat exchangers, basic equation of radiation.

Laboratory work: Stefan boltzman's constant calculations, natural and forced convection, LMTD calculations for parallel and counter flow, determination of thermal conductivity through composite wall, lagged pipe, lagged cylinder, sphere, sedimentation and calculation of terminal velocity, performance of packed bed apparatus, fluidized bed apparatus: pressure drop vs. flow rate, drying rate.

Course Learning Outcomes (CLO):

Students will be able to

1. differentiate between dimensions and units and apply the concepts of unit consistency.
2. describe and explain basic principles of fluid flow for ideal and non ideal fluids.
3. apply and explain basic principles of heat and mass transfer operations.
4. solve simple cases of fluid flow, heat and mass transfer.
5. perform simple calculations of unit operations involved in a biotechnology industry.

Text books

1. *W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 5th edition, McGraw-Hill (1993).*
2. *Treybal, R.E., Mass Transfer Operations, McGraw Hill (1980) 3rd Ed.*
3. *Holman, J.P., Heat Transfer, Tata McGraw-Hill Education (2008).*

Reference Books

1. *Perry's Chemical Engineers' Handbook, Don Green, 8th edition.*
2. *P. M. Doran, Bioprocess Engineering Principles, Academic Press.*

Evaluation Scheme:

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

UEN002: ENERGY AND ENVIRONMENT

L	T	P	Cr
3	0	0	3.0

Course Objectives: 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.

Detail contents

Natural Resources: Human settlements and resource consumption; Biological, mineral and energy resources; Land, water and air; Natural resources vis-à-vis human resources and technological resources; Concept of sustainability; Sustainable use of natural resources

Ecology, Structure and Functioning of Natural Ecosystems: Ecology, ecosystems and their structure, functioning and dynamics; Energy flow in ecosystems; Biogeochemical cycles and climate; Population and communities

Agricultural, Industrial Systems and Environment: Agricultural and industrial systems vis-à-vis natural ecosystems; Agricultural systems, and environment and natural resources; Industrial systems and environment

Environment Pollution, Global Warming and Climate Change: Air pollution (local, regional and global); Water pollution problems; Land pollution and food chain contaminations; Carbon cycle, greenhouse gases and global warming; Climate change – causes and consequences; Carbon footprint; Management of greenhouse gases at the source and at the sinks

Energy Technologies and Environment: Electrical energy and steam energy; Fossil fuels, hydropower and nuclear energy; Solar energy, wind energy and biofuels; Wave, ocean thermal, tidal energy and ocean currents; Geothermal energy; Future energy sources; Hydrogen fuels; Sustainable energy

Group Assignments: Assignments related to Sanitary landfill systems; e-waste management; Municipal solid waste management; Biodiversity and biopiracy; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels; Environmental status assessments; Energy status assessments, etc.

Course Learning Outcomes (CLO):

Students will be able to:

1. outline the scenario of natural resources and their status
2. calculate the flow of energy and mass balance in ecosystems
3. analyse environmental status of human settlements
4. monitor the energy performance of systems

Text books:

1. *Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).*
2. *Chapman, J.L. and Reiss, M.J., Ecology- Principles and Application, Cambridge University Press (LPE) (1999).*
3. *Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).*
4. *Eastop, T.P. and Croft, D.R. Energy Efficiency for Engineers and Technologists, Longman and Harow (2006).*

Reference Books:

1. *Miller, G.T., Environmental Science- Working with Earth, Thomson (2006).*
2. *Wright, R.T., Environmental Science-Towards a sustainable Future, Prentice Hall (2008).*
3. *O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).*

Evaluation Scheme

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	50
3.	Sessionals (May include assignments/quizzes)	20

Course Objectives: The objective of the course is to understand the interplay between, psychological, ethical and economic principles in governing human behavior. The course is designed to help the Students to understand the basic principles underlying economic behavior, 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.

Detail contents

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 Behavior: 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.

Practicals:

1. Experiments on learning and behavior 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 behavior.

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 macroeconomic issues. 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.

Course Learning Outcomes (CLO):

Upon the successful completion of this course, Students will be able to:

1. improve the understanding of human behaviour 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 Students) (1986).*
2. *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	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT404: INDUSTRIAL BIOTECHNOLOGY

L T P Cr

3 0 2 4.0

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.

Detail contents

Introduction to Industrial Biotechnology: Overview of fermentation and other industries with their commercial products employing the use of microorganisms; strain improvement through mutation and recombination in industrial microorganisms, Integrated Strain improvement program (Precision Engineering Technology), biosynthetic technology.

Microbes in agriculture and food industry: beneficial soil microorganisms, biofertilizers and biopesticides, SCP, microbial production of wine, beer and vinegar; biopreservatives (Nisin), cheese, biopolymers (xanthan gum, PHB etc), vitamins; Bioflavours and biopigments; microbial production of flavours and fragrances; microbial pigments in textile and food industry.

Process technology for the production of cell biomass and primary metabolites- ethanol, acetone-butanol, citric acid, dextran and amino acids.

Production of enzymes and specialty chemicals: Production of industrial enzymes such as proteases, amylases, lipases, cellulases, whole cell biocatalysis, Applications of bioconversion, transformation of steroids and sterols; production of acrylamide, adipic acid, 1,2- propanediol

Microbial production of pharmaceuticals and other bioproducts: Antibiotics, enzyme inhibitors and specialty chemicals; production of Vitamin E, K, B₂ and B₁₂, glutamic acid, L-Lysine. Transformation of non-steroidal compounds, antibiotics, genetic engineering of microorganisms for production of non-ribosomal peptides (NRPS) and polyketides (PKS), anticancer drugs.

Bioenergy-fuel from biomass, production and economics of biofuels, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR).

Laboratory work: 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 Outcomes (CLO):

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. *Glazer AN, Nikaido H (2007): Microbial Biotechnology: Fundamentals of Applied Microbiology*
2. *Wulf Cruger and Anneliese Crueger (2003), Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation.*
3. *Malden MA (2001): Industrial Microbiology: An introduction; Blackwell Science (2001)*

Reference Books

1. *H.W. Blanch, S. Drew, D.I.C.Wang and M. Moo-Young, Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products, Pergamon Press (1985).*
2. *C. Vogel and C.L. Tadaro, Fermentation and Biochemical Engineering Handbook: Principles, Process, Design and Equipment, Noyes Publications (1996).*
3. *P.F. Stansbury and A. Whitaker, Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press (1993).*

Evaluation Scheme

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

UBT503 GENETIC & METABOLIC ENGINEERING

L	T	P	Cr
3	0	2	4.0

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

Detail Contents:

Introduction: Scope of genetic engineering, Milestones in genetic engineering: isolation of enzymes, DNA sequencing, synthesis and mutation, molecular cloning, gene expression, cloning and patenting of life forms, genetic engineering guidelines.

Principles and techniques of recombinant DNA technology: Basic molecular techniques, Different hosts for molecular cloning, Host restriction and modification, Restriction and other enzymes; Cloning vectors: plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, YAC, BAC, Restriction mapping of DNA fragments, Genomic and cDNA libraries, Molecular techniques for cloning, screening, expression and regulation studies of genes, DNA labelling, DNA and protein sequencing, Polymerase Chain Reactions (PCR), DNA fingerprinting, RAPD, Site-directed mutagenesis, Expression strategies for heterologous genes in bacteria, yeast, insect cells and mammalian cells, Molecular markers, Detecting protein-protein interactions, High-throughput techniques, Gene therapy

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.

Laboratory work: Bacterial transformation, Isolation of plasmid/bacteriophage DNA, Restriction analysis of DNA, Cloning in plasmid vectors, Construction and screening of gene library, Different PCR techniques, Gene expression in bacterial hosts and analysis of gene products, Reporter gene assay.

Course Learning Outcomes (CLO):

Students will be able to

1. apply landmark discoveries in developing a number of facile molecular techniques used in rDNA technology.
2. learn how to select the suitable hosts for the individual vectors for different purposes.
3. know the extraordinary power of restriction and other enzymes in molecular cloning and genetic manipulations.
4. perform application of PCR in rDNA technology.
5. perform expression of the cloned gene (s) for basic and applied research.
6. gain hands-on training in various molecular techniques for gene manipulation.

Text books

1. Primrose, S.B. and Twyman, R.M., *Principles of Gene Manipulation and Genomics*, Blackwell Publishing (2006).
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T., *Lewin's GENES X*, Jones and Bartlett Publishers (2011).

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:

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

UBT801: BIOSAFETY, BIOETHICS & IPR

L T P Cr

2 1 0 2.5

Course Objectives: To introduce basic concepts of ethics and safety that are essential for various branches of science involving technical procedures and protection of intellectual property and related rights. To understand balanced integration of scientific and social knowledge in sustainable development.

Detail contents

Biosafety: History, evolution and concept of biosafety; need and application of biosafety in laboratories and industries; biosafety guidelines and regulations, international and national norms of biosafety; Implementation of biosafety guidelines; Classification and Description of Biosafety levels; Design of clean rooms and biosafety cabinets; Risk assessment and containment levels; biohazard, bio-medical and hazardous wastes, handling and disposal; transportation of biological materials; bio-terrorism; biosafety protocol (Cartagena biosafety protocol) regulations to protect nature, growers and consumers interest and nation interest; Good laboratory practice (GLP) and Good manufacturing practice (GMP), Use of GMO's and their release, GM products, issues in use of GMO's, risk for animal/human/agriculture and environment owing to GMOs.

Bioethics: Introduction and need of bioethics, its relation with other branches, types of risk associated with genetically modified microorganisms, Ethical Issues involving GMOs; ethics related to human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, data privacy of citizens health; ethical issues in India and abroad 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.

Course Learning Outcomes (CLO):

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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT602 BIOINFORMATICS & BIOSTATISTICS

L T P Cr

3 0 2 4.0

Course Objective: The objective of this course is to familiarize Students with basic concepts of sequences, structural alignment, database searching, protein structure prediction and computer-based drug designing. The course will also provide understanding of the fundamentals of statistics, methodology and theory of statistics and their application for solving the problems in the field of life sciences.

Detail contents:

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats, DNA and protein sequence databases, Structure databases

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

Statistics – Introduction to statistics, sampling, variables and data; measures of central tendency and dispersion, Shannon entropy, sampling techniques; probability and distribution; normal, binomial and Poisson probability distribution, Bayesian statistics, test of hypotheses; confidence limits and tests of confidence; introduction to ANOVA; non-parametric tests, correlation and regression, rank correlation, 2x2 contingency table analysis, chi-square test, Design of experiments.

Laboratory Work: DNA and protein sequence and PDB file formats, Local and global sequence alignment of protein and DNA sequences, Needleman Wunsch and Smith-Waterman algorithm, BLAST, Multiple sequence alignment, Phylogenetic tree construction, MS Excel and Graphpad Prism software, data entry and graphical representation, equation formulation and analysis for sample testing, non-parametric tests, correlation and regression, ANOVA, multiple comparisons.

Course Learning Outcomes (CLO):

Students will be able to

1. perform alignment of sequences and construct the matrix for alignment based on dynamic programming
2. construct the phylogenetics of different sequences.
3. analyze sequence and structure of bio-macromolecule data
4. edit the three dimensional structure of protein using structural bioinformatics tools
5. classify various types of data and apply basic statistical concepts such as measures of central tendencies, measures of dispersion and sampling.
6. use concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis.

7. perform statistical hypothesis testing using tools such as t-test, ANOVA, Tukey test and Chi-square test.

Textbooks

1. *Xiong J, Essential Bioinformatics, Cambridge University Press (2006)*
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 (2008)*
4. *Zar, J. H., Biostatistical analysis (Fifth edition), Pearson Prentice Hall publication, ISBN 978-0-13-100846-5*
5. *Rao, K. V., Biostatistics – A manual of statistical methods for use in health, nutrition and anthropology (Second edition), JAYPEE Brothers Medical Publishers Pvt. Ltd., ISBN 81-8448-055-5*

Reference Books

1. *Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).*
2. *Gupta S. C. and Kapoor, V. K., Elements of mathematical statistics (Third edition), Sultan Chand & Sons Publishers, ISBN 81-7014-290-3*
3. *Mahajan, B. K., Methods in biostatistics (Sixth edition), JAYPEE Brothers Medical Publishers Pvt. Ltd., ISBN 81-7179-520-X*

Evaluation Scheme:

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

UBT605 : PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The Students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation. The Students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Detail contents

Introduction to Plant Biotechnology and its scope

Plant tissue culture—its history, development and applications, Plant tissue culture media, Types of cultures, Callus cultures, Cell and suspension cultures, Single cell clones, Protoplast culture and somatic hybridization.

Micropropagation: Techniques and various steps involved in micropropagation, Production of disease free plants, Commercial aspects and limitations of micropropagation

Production of haploid plants: Androgenesis and Gynogenesis and production of homozygous lines, Significance and uses of haploids

Embryo culture and embryo rescue and its applications in plant improvement.

Secondary metabolite extraction: Primary vs secondary metabolites, Production of secondary metabolites and other compounds using plant cell culture, Hairy root culture, Immobilized cell system, Elicitation and Biotransformation.

Germplasm conservation: various approaches for Bioconservation, *in vitro* techniques especially cryopreservation in germ plasm conservation

Recombinant DNA Technology and Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, Gene transfer methods—Vector mediated, Virus mediated and Vector less DNA transfer, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, Improvement of crop yield and quality, Molecular markers and marker assisted selection, Applications of plant transformations/ transgenics, Commercial transgenic crops.

Molecular farming: of Alkaloids, Useful enzymes, Therapeutic proteins, custom- made Antibodies, Edible vaccines.

Laboratory Work: Plant tissue culture media, Explant preparation, Callus induction and differentiation, microscopic study of callus, Meristem culture for virus free plants, Rooting of plantlets and acclimatization, Protoplast isolation, Preparation of artificial seeds, Isolation and purification of plant DNA and RNA, Quantification of DNA, restriction analyses, *Agrobacterium*-mediated transformation of plants, transformation by biolistic gun

Course Learning Outcomes (CLO):

Students will be able to:

1. Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization & measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.

2. Learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology
3. Learn the large scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under *in vitro* conditions
4. A good understanding of r-DNA technology, methods of gene transfer, molecular markers and marker assisted selection
5. Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement

Text books

1. Slater, A., Scott, N.W., and Fowler, M.R., *Plant Biotechnology*, Oxford University Press (2008) 2nd ed.
2. Razdan, M.K., *Introduction to Plant Tissue Culture*, Science Publishers (2003) 2nd ed.

Reference Books

1. Primrose, S.B. and Twyman, R.M., *Principles of Gene Manipulation and Genomics*, 7th Edition, Blackwell Publishing (2006) 7th ed.
2. Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., *Concepts in Biotechnology*, Universities Press (1999).
3. Satyanarayana, U., *Yeast Biotechnology: Diversity and Applications*, Springer (2009).

Evaluation Scheme

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

UBT508: TRANSDUCERS AND BIOSENSORS

L T P Cr

3 1 2 4.5

Course Objectives: 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.

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

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

Course Learning Outcomes (CLO):

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	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

UBT603: BIOPROCESS ENGINEERING

L	T	P	Cr
3	1	2	4.5

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.

Detail contents:

Introduction: Interaction of two disciplines: biology and bio-chemical engineering, historical advancement in fermentation processes, current status of biochemical engineering in fermentation industry, range of microbial diversity in fermentative processes.

Microbial Growth Kinetics: Growth, growth measurement, media formulation, stoichiometry of cell growth and product formation, factors influencing product formation on varying carbon & nitrogen source, batch culture, Monod's kinetics, modeling 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.

Aeration and Agitation: 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 (K_{La}) and its determination, factors affecting K_{La} values in a bioreactor, power requirements in gassed and ungassed bioreactors, rheological characteristics of fermentation fluids.

Bioreactor Selection and Design: 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.

Sterilization, Instrumentation and Process Control: Need of sterilization, media sterilization, Del factor, design of batch and continuous sterilization, air sterilization, log penetration theory, scale up of sterilization process, filter design, 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.

Laboratory work: Bacterial growth kinetics, effect of varying carbon substrate on specific growth rate, production of citric acid and lactic acid, comparative study on rate of product formation using immobilized and suspension cells, K_{La} determination using non-fermentative and fermentative methods, effect of mixing and agitation rate on K_{La} ,

Course Learning Outcomes (CLO):

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 bioreactor 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 analyze a bioprocess.

Text books

1. *P.F. Stanbury and A. Whitaker-Principle of Fermentation Technology; Pergamon Press (1988).*
2. *M. L. Shuler and F. Kargi-Bioprocess Engineering: Basic Concepts” by, 2nd Edition, Pearson Education (2001).*
3. *P. M. Doran-Bioprocess Engineering Principles Academic Press (2012).*

Reference Books

1. *J. E. Bailey and D.F. Ollis-Biochemical Engineering Fundamentals, McGraw-Hill Book Co., New York (1986)*
2. *S. Aiba, A. E. Humphrey, N. F. Millis-Biochemical Engineering, Academic Press, New York 2nd Edition (1973).*

Evaluation Scheme:

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

UBT601 ANIMAL BIOTECHNOLOGY

L T P Cr

3 0 2 4.0

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.

Detail contents:

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 non-viral 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-splitting, 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, RAPD,

Laboratory work: Laboratory Design & Instrumentation in ATC, Quality Assurance in Animal tissue culture facility, Preparation of animal cell culture media, Isolation and Culturing Peripheral Blood Lymphocytes, Viability assay, Cryopreservation technique, Sub-culturing and maintenance of Cell line, In vitro anticancer assay (MTT Assay), Genomic DNA Isolation from Blood and Tissue.

Course Learning Outcomes (CLO):

Students will be able to

1. explain the fundamental scientific principles that underlie cell culture
2. acquire knowledge for isolation, maintenance and growth of cells.
3. develop proficiency in establishing and maintaining of cell lines.
4. acquire knowledge in animal cloning and its applications

TextBooks

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

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

Evaluation Scheme:

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

UBT606: DOWNSTREAM PROCESSING

L	T	P	Cr
3	1	2	4.5

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

Detail contents:

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 centrifuge (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: Adsorption, Ion exchange, gel permeation, affinity, HPLC, Crystallization, Drying, Types of drying (spray drying, vacuum drying, freeze drying, Electrophoresis: Theory of electrophoresis, Gel electrophoresis, Isoelectric focusing. Case studies: downstream processing of baker's yeast, citric acid,

Laboratory work: Optimization of flocculating agent concentration, comparative cell disruption methods, Batch settling process, filtration efficiency, protein precipitation by salting-out method, adsorption process in batch mode, Ball milling, Batch drying, Qualitative and quantitative estimation of product using GC, HPLC.

Course Learning Outcomes (CLO):

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. *P.A. Belter, E.L. Cussler and W.Shou Hu-Bioseparations-Downstream Processing for Biotechnology, Wiley- Interscience Publication, (1988).*
2. *R. G. Harrison, P. Todd, S. R. Rudge, D. P. Petrides-Bioseparations Science and Engineering, Oxford University Press*
3. *B Sivasankar-Bioseparations - principles and techniques , Prentice Hall of India, New Delhi (2003)*

Reference Books

1. *Satinder Ahuja-Handbook of Bioseparations, Academic Press, United States (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	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

UBT607: STEM CELL TECHNOLOGY

L T P Cr

3 1 0 4.0

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.

Detail contents

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, EScells. 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.

Course learning outcomes (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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

Course Objective: To provide basic knowledge about food processing and preliminary preparation of food before actual processing steps. To know the effect of processing and preservation techniques on physical, chemical and microbiological properties of food. To provide knowledge and application of working principle of various food preservation techniques and their mechanism of action on enzymes and microbes.

Detail contents

Raw material for processing: Food processing introduction in foods, properties of food raw materials, cleaning of raw materials, handling and management of raw materials (cleaning, sorting, grading and handling during transportation etc.)

Thermal Processing: Introduction, classification of Thermal Processes, principles of thermal processing and on that basis different methods like blanching, pasteurization, canning, sterilization etc., factors affecting thermal resistance of microorganisms and their spores, thermal death time, lethality concept, characterization of heat penetration data, thermal process calculations, commercial thermal processing equipments.

Cold processing: Refrigeration and Cold Storage, Freezing and Frozen storage and their side effect. Freezing: requirements of refrigerated storage (controlled low temperature, air circulation and humidity), changes in food during refrigerated storage, progressive freezing and changes during freezing (concentration effect and ice crystal damage, freezer burn). Refrigeration load, factors determining freezing rate (food composition and non compositional influences). Freezing methods (direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing), their mechanism of action on microbes and enzymes activity.

Evaporation and Dehydration: Factors influencing evaporation process. Types of dehydration and their comparison. Normal drying curve, effect of food properties on dehydration, change in food during drying, drying methods and equipments air convection dryer, tray dryer, tunnel dryer, continuous belt dryer, fluidized bed dryer, dryer, drum dryer, vacuum dryer, freeze drying, foam mat drying.

Food Irradiation and Microwave heating: Introduction and history of irradiation in food, doses, Units of measurement, usage levels. Mechanism of killing of micro-organisms and factors affecting irradiation against micro-organisms, radiation resistance of micro-organisms, Microbiological terminology on the basis of the irradiation usage and their applications. Effect on the nutritional content of the foods. Microwave Heating: working principle, components, food applications, mechanism of heating and effect on micro-organisms, pros and cons.

Other processes and preservation techniques: Filtration, Carbonation, Smoking, Preservatives (Natural and Artificial), Curing and Ageing techniques in meat, fermentation, Antibiotics usage and side effects. Recent methods in food processing and preservation: pulse electric field, high pressure, ultrasound, microwave, ohmic and infrared heating. Packaging and Labelling.

Laboratory work: Cleaning of the food raw materials, sorting, grading mechanisms in various food groups. Thermal processing: blanching, pasteurization and sterilization. Designing of a thermal process on the basis of the killing of the microorganism on a particular food. Sun Drying and dehydration differences in the food sensory characteristics. Microwave processing. Concentration of food products. Filtration, Carbonation, fermented products. Action of antibiotics from LAB on milk and fruit juices yeast growth. An introductory knowledge about different processors, equipments and analytical instruments used in Food Industry. Quality testing of different packaging materials.

Course Learning Outcomes (CLO):

Students will be able to

1. define and explain different preliminary steps before food processing.
2. comprehend the working principle and mechanism of action of individual food processing method on microorganisms and enzyme activity to the increase shelf life.
3. apply various food processing and preservative techniques on the nutrient composition and sensory characteristics.
4. comprehend phenomenon of food degradation and spoilage by microorganisms with change in the processing conditions along with importance of packaging and labelling.
5. combine need for different food processing and preservation techniques

Textbooks.

1. Norman N. Potter and Joseph H. Hotchkiss - *Food Science*, 5th ed. (2007)
2. M. Shafiur Rahman *Handbook of Food Processing*, 2nd Edition, CRC Press Taylor and Francis group (2007)
3. Frazier William C and Westhoff, Dennis C.)- *Food Microbiology*, TMH, New Delhi. (2004)
4. B. Sivasankar (*Food Preservation*, PHI Learning (2002)

Reference Books

1. Avantina Sharma *Textbook of Food Science & Technology (Vol-I & II)*, International Book Distributing Company, 1st ed. (2006)
2. Cheung, Peter C. K., Mehta, Bhavbhuti M. *Handbook of Food Chemistry*, Springer-Verlag Berlin Heidelberg, 1st Edition. (2015)
3. 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)

Evaluation Scheme:

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

UBT609: MEDICAL BIOTECHNOLOGY

L	T	P	Cr
3	1	2	4.5

Course Objectives: 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.

Detail contents:

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; Immunosuppressors in organ transplants; Role of cytokine therapy in cancers;

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

Laboratory work: Chromosome preparations-PHA-stimulated short-term blood cultures, air-dried chromosome preparations. G-banding of chromosomes. Blood urea analysis by diacetyl monoxyme method. Analysis of acid and alkaline phosphatase from serum samples Estimation of serum cholesterol, Assay of SGOT enzyme activity, Assay of SGPT enzyme activity, Blood sugar analysis by Folin -Wu method, Estimation of Creatine and Creatinine from urine samples

Course Learning Outcomes (CLO):

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	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

UBT604: PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objectives: 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.

Detail contents:

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. Packaging material and techniques. Quality control of pharmaceutical products as per pharmacopoeia. Microbial assays of vitamins and antibiotics. Stability studies, Method validation.

Biotechnology derived pharmaceuticals. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Regulatory issues in pharmaceutical products.

Laboratory work: Quality control of antibiotic and non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic methods as per IP/US Pharmacopoeia. Microbiological assays of vitamins and antibiotics. Sterility testing and stability testing of parenteral formulations.

Course Learning Outcomes (CLO):

Students will be able to

1. explain the strategies 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
5. explain the regulatory aspects in the development of pharmaceuticals.

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	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT702: Industrial Waste Management

L T P Cr

3 1 0 3.5

Course Objective: To enable Students to learn about waste production through different unit operations in different biotech and related industries and mandatory regulations dictated by regulatory authorities deciding the final throughput of the waste disposal.

Introduction: Waste, its classification on different basis, typical unit operations leads to waste production in a particular Industry. Environmental analysis of industrial facilities; Preparation of waste inventory and identification of environmental aspects; Waste minimization through source reduction and through recycling and reuse of wastes; Housekeeping activities and their role in the industrial wastes management; US EPAs waste management hierarchy; and Pollution prevention programs.

Liquid waste collection, treatment and disposal systems: Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system.

Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions; Operation and maintenance of air pollution control devices; a case of a system for the collection, treatment and discharge of industrial emissions.

Solid waste management and treatments: Solid and hazardous waste handling and management: Facilities and organization setup for the collection, treatment, storage, transportation and disposal of hazardous wastes; handling and disposal of wastes like packaging waste, fly ash, lime sludge, and other non-hazardous wastes.

Regulatory requirements and environmental functions of industrial facilities: Consents, clearances and authorizations; Mandatory reports and returns to be prepared and submitted; Environmental standards; Requirements related to the handling and management of hazardous materials and hazardous wastes; Environmental management systems (EMS) and ISO 14000 series of standards; and Environmental audits in India.

Course Learning Outcomes (CLO):

Students will be able to:

1. Apply the knowledge on categories of industrial waste and their treatment
2. Assess the efficiency of various techniques to manage and dispose hazardous industrial wastes
3. Identify the regulatory requirements for handling and disposal of industrial waste

Text books

1. Pichtel, J., *Waste Management Practices: Municipal, Hazardous and Industrial*, Taylor and Francis (2005).
2. Buclet, N., *Municipal Waste Management in Europe*, Springer (2002).

Reference Books:

1. Liu, D.H.F. and Liptak, B.G., *Environmental Engineers' Handbook*, Chapman Hall – CRC Press (1999).

Evaluation Scheme:

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

UBT704: Trends in Food Biotechnology

L T P Cr

3 1 0 3.5

Course objective: To make Students learn about current trends in food biotechnology in relation with modern biotechnological and biochemical interventions aiming towards food safety and food security.

Introductory Terminology: Food, Food science, food microbiology, food safety, food processing, food engineering, food biotechnology, food physics, food biochemistry, foods and nutrition etc.

Pathways to food biotechnology: Recombinant DNA Technology, Microbial and Diagnostic Biotechnology, Controversial Aspects of Food Biotechnology, Food Security

Consumer and food: Food Quality (perception, organoleptics and relation of nutrition to health).

Food hazards: Physical, chemical, microbial (parasitic and viral) and engineered hazards: their threats; methods for detection and documentation.

Vegetarian sources in food biotechnology: Nutraceuticals, their role in disease alleviation, processing options for functional foods, functionality of foods in the real time scenario, production and commercial outlook. Functional foods, Bioactive components or functional molecules, molecular nutrition, antioxidant activity, therapeutic foods, Nutrigenomics, Proteogenomics etc. Genetically modified foods: Plant and animal GM foods (Transgenic Fish, Modified Milk Proteins), consumer perception, risks of GM foods, analysis and tracking of GM foods, national and international status, case studies.

Human micro flora and other useful micro-organisms: Gut microflora, its sustainability, combinations, prebiotics, probiotics, symbiotic foods, Antibiotics produced from micro-organisms (LAB, Fungi and Moulds etc.) and application in foods like Bacteriocins: Introduction, Classification, mode of action, Applications of bacteriocins etc., Selected fermented food production processes utilizing the useful microbes: milk, tea, coffee, liquor, vinegar, wine, soy sauce, bread, mushroom and others like vitamins, enzymes, flavours and amino acids etc.

Food safety issues of new biotechnologies: National and international norms, Traceability, HACCP, GMP, GAP, SPS, TQM, Six sigma, EIA and ISO.

Food designing and processes: Advanced and conventional processing methods and their effects on nutrition of foods, biotechnology intervention in food packaging and labelling (Nutritional claim and health claim), designing safe and nutritious foods.

Course Learning Outcomes (CLO):

Students will be able to:

1. identify tools of biotechnological interventions towards food security and safety
2. comprehend various food quality parameters, food hazards and their control.
3. comprehend utilization of novel vegetarian food sources their compositions and health benefits.
4. assess human micro-flora, mode of action of useful microbial sources in food.
5. design new food products with better quality and applications.

Text books

1. *Shetty, K., Plaiyath, G., Pometto, A. and Levin, R.E., Functional Foods & Biotechnology, CRC Press (2006).*
2. *Shetty, K., Plaiyath, G., Pometto A. and Levin, R.E., Food Biotechnology, CRC press, (2005).*

Reference Books

1. *Byong H. Lee, (2014)- Fundamentals of Food Biotechnology, 2nd Edition, Wiley-Blackwell.*
2. *Perry Johnson-Green,(2002) - Introduction to Food Biotechnology, CRC Press.*

Evaluation Scheme:

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

UBT802: NANOBIO TECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: To make Students acquainted with the fundamental concepts of nanotechnology and develop an understanding to employ its principles in modern biotechnology applications.

Detail contents:

Basic Concepts of Nanoscience: Importance of "Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, applications of nanotechnology, challenges and future prospects, effect of 'nano' scale on material properties (electrical, thermal, mechanical, optical, chemical), quantum structures, quantum confinement, classification of nanostructured materials, surface effects of nanomaterials

Synthesis and Characterization of Nanomaterials: Bottom-up and bottom-down approaches: milling, arc discharge, laser ablation, spray pyrolysis, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembled monolayer, Characterization of nanostructures, Spectroscopy: UV-Vis, FTIR; Electron microscopy: Scanning electron microscopy, EDX, Transmission electron microscopy, Atomic force microscopy.

Engineered Nanomaterials for Biological Applications: Current status of nanobiotechnology, biogenic synthesis of nanoparticles: microbial and plant mediated, surface functionalization of nanomaterials, biological applications of functionalized nanomaterials, Biological nanomachines: ribosomes, photosynthesis systems, Bionanomotors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and biopesticides delivery applications.

Biomedical Applications and Nanotoxicity: Biopolymers, Polymeric biomaterials, lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, DNA nanotechnology, Nano-biosensors: fabrication, functionalization, applications, Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry.

Course Learning Outcomes (CLO):

Students will be able to

1. Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.
2. learn various approaches of synthesizing nanomaterials, their advantages and limitations.
3. gain knowledge about various techniques used for characterizing nanomaterials.
4. comprehend the importance of engineered nanomaterials for biomedical, therapeutic and environmental applications.
5. evaluate the potential toxic effects of nanotechnology on living organisms and the environment.

Text books

1. *"Nanostructures and Nanomaterials: Synthesis, Properties and Applications"*, G. Cao, Imperial College Press (2004)
2. *Nanobiotechnology; Concepts, Applications and Perspectives"*, C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004)
3. *" Bionanotechnology: In Nanoscale Science and Technology"*, G. J. Leggett, R. A. L. Jones, John Wiley & Sons, (2005)

4. *"Textbook of Nanoscience and Nanotechnology"*, B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday, Universities Press-IIM (2012)
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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT822: ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

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.

Detail contents:

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

Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal, composting technologies. Biofuel production: biogas, bioethanol, biohydrogen and biodiesel

Bioremediation and Biodegradation: Introduction and types of bioremediation, bioremediation of surface soil and sludge, Microbial Systems for Heavy Metal Accumulation, Biosorption & detoxification mechanisms., metal Bioleaching and bio-oxidation *In situ* and *Exsitu* 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, degradative plasmids, release of genetically engineered organisms in environment, Biosensor Technology for monitoring pollutants.

Laboratory work: Determination of organic carbon, nitrogen, phosphorus in soil, Determination of MPN, Fecal Coliform, BOD; COD; DO; TSS; TDS in different water and wastewater samples, Selective enrichment methods for isolation of contaminant tolerant microorganisms, Analysis of metals and pesticides, Toxicity Assessment, Biosensors.

Course Learning Outcomes (CLO):

Students will be able to

1. comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments
2. comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals
3. apply biotechnological processes in waste water and solid waste management.
4. comprehend biofuels/bioenergy systems; attributes for biofuel / bioenergy production.
5. demonstrate innovative biotechnological interventions to combat environmental challenges.

TextBooks

- 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	Weight age (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

UBT832: CONCEPTS IN BIOMEDICAL INSTRUMENTATION

L T P Cr

3 1 2 4.0

Course Objectives: 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.

Details contents:

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, Echo-cardiograph.

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 pCO₂ & pO₂, 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: 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 outcomes (CLO):

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	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessionals (May include assignments/quizzes)	40

Elective 1

UBT621: COMPUTATIONAL BIOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: To understand the basics of computational science and apply it to solve biological problems. To learn about developing algorithms for solving complex biological problems as theoretical level.

Detail contents:

Programming: Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Linked, List concepts. BioPerl language, programming using BioPerl

Complexity of algorithms –NP complete problem- polynomial-Reducibility-sorting problem and Fibonacci Problem; Algorithm types: Linear, Exhaustive search, Branch and Bound, divide and conquer, Expectation and Maximization (EM) with forward and backward algorithms, discriminative learning, Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and maximum likelihood algorithm

Dynamic programming methods of sequence analysis: Principles and its uses. Hidden Markov models in sequence analysis. Introduction of Markov Chain and Hidden Markov models. Forward-backward algorithm, Viterbi and Baum-Welch algorithms, Heuristics second generation alignment tool (Blast, FASTA, ClustalW), Monte Carlo method, Molecular dynamics

Molecular computational biology: Gene prediction, sequencing genomes, similarity search, restriction mapping, DNA binding motif finding by sequence alignment, Gibbs sampling approaches

Laboratory Work: BioPerl programming, Multiple sequence alignment, DNA binding motif finding by sequence alignment

Course Learning Outcomes (CLO):

Students will be able to

1. perform programming in BioPerl programming language.
2. explain various types of algorithms with their possible application in solving biological problems.
3. explain underlying algorithms for sequence analysis
4. use HMM and other algorithms
5. explain the computational aspects of complex biotechnological 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*

Evaluation Scheme:

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

UBT622: CELL AND TISSUE ENGINEERING

L T P Cr

3 1 0 3.0

Course Objectives: 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.

Detail contents

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

Biomaterials & 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.

Course learning outcome (CLO):

The Students will be able to:

1. comprehend the structural organization of cells and tissues, the role of cell interaction, cell migration, wound healing and cellular processes
2. describe the different biomaterials and its properties, design, fabrication and biomaterials selection criteria for tissue engineering scaffolds
3. comprehend applications of tissue engineering

Text books:

1. *Principles of tissue engineering*, Robert. P.Lanza, Robert Langer & William L. Chick, Academic press.
2. *The Biomedical Engineering –Handbook*, Joseph D. Bronzino, CRC press.
3. *Introduction to Biomedical Engg.* , Endarle, Blanchard & Bronzino, Academic press.

Reference books:

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

Evaluation Scheme:

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

UBT623: PROTEIN ENGINEERING AND ENZYME TECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objective: To make Students learn structural and functional relationships in proteins and altering their structure in order to function 'better'. To provide basic knowledge of enzyme technology and use of enzymes as tools in industry, agriculture and medicine.

Detail contents:

Protein structure and function: Introduction to protein engineering; salient features of amino acids and their –R groups; conformation of proteins, the Ramachandran plot, folding, tertiary structure and structural domains and motifs of proteins; analysis of protein structure by CD spectroscopy, MALDI-TOF NMR, X ray diffraction studies; prediction of protein structure and conformation from sequence data, relationship between structure and function.

Protein Engineering and Design: Methods in protein engineering and design – physical, computational, biochemical and molecular techniques; protein engineering in lysozyme and pepsin class of enzymes; chemical modifications of proteins; protein design, design of peptide and protein mimics.

Enzyme Technology: Aim and scope of enzyme technology; strategies of isolation and purification of enzymes from different sources; identification of binding and catalytic sites; use of enzymes in free solution and associated problems; stabilization of soluble enzymes; enzyme reactions; applications of enzymes in food industry, pharmaceutical, medical and analytical purposes; objectives of enzyme immobilization, methods of enzyme immobilization-adsorption, entrapment, direct covalent linkage, cross-linking; immobilized enzyme reactors - batch, continuous and membrane reactors; applications of immobilized enzymes for industrial-scale conversions, manufacture of commercial products, enzyme electrocatalysis - immobilization of enzymes onto electrodes, measurement of enzyme activity, regeneration of cofactors; *basic principles of biosensors and use of enzymes in biosensors.*

Course Learning Outcomes (CLO):

Students will be able to

1. comprehend the importance of R groups of the amino acids in any protein/enzyme.
2. know about domains and motifs in a protein and the basis of their prediction
3. know relationship between structure and function of a protein
4. design different strategies for protein engineering and protein design
5. know the principles of isolation and purification of enzymes from various sources
6. comprehend various methods involved in enzyme technology and their commercial applications.

Text books:

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, and Jayaraman R, *Concepts in Biotechnology*, Universities Press (2007).
2. Rastogi SC, Mendiratta N and Rastogi P, *Bioinformatics - Methods and Applications*, PHI (2006).
3. Satyanarayana, U, *Biotechnology, Books and Allied (P) Ltd.* (2005).
4. Smith JE, *Biotechnology*, Cambridge University Press (2006).

Reference Books:

1. Berg JM, Tymoczko JL and Stryer L, *Biochemistry*, W H Freeman and Company (2002).
2. Creighton TE, *Protein-Structure and Molecular Properties*, W.H. Freeman and Co. (1997).
3. Primrose SB and Twyman RM, *Principles of Gene Manipulation and Genomics*, Blackwell Publishing (2006) 7th ed.
4. Sambrook J, Fritsch EF, Maniatis T, *Molecular Cloning: A Laboratory Manual*, Cold Spring Harbor Laboratory (1999)

Evaluation Scheme:

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

UBT834: BIOPROCESS EQUIPMENT DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objective: This course is designed to integrate basic concepts of bioprocess engineering gained in earlier courses to mechanical aspects while designing a bioprocess plant. This course also imparts knowledge of scale up of bioprocesses for the production of biochemical products.

Detail contents:

Introduction: general design information, important mechanical properties of materials, yield stress, proof stress, materials of construction, protective coatings of equipment's, *GMPs guidelines*, validation, safety in bioprocess plant

Design Consideration: Stress analysis: static and dynamic loads, Elastic instability, combined stresses, theories of failure, Design considerations for maintaining sterility of process streams and process equipment, Design wall thickness, Design pressure, Design temperature, Design stress, corrosion allowance, design loads, minimum wall thickness, Pressure vessels: classification, design of vessels under internal and external pressure

Bioreactor Design and Scale-up: Design criteria for airlift, bubble column, and chemostat bioreactors, power requirements for newtonian/non-newtonian broths and gassed fluids, Bioreactor scale-up based on constant power consumption per volume (P/V), mixing time, shear, mass transfer coefficients, Effect of variables on bioreactor performance while scaling up: aeration and agitation, mixing, sterilization of media and bioreactor, inoculum development, nutrient availability, shear, pH, and Temperature.

Bioprocess Flow Design and Economics: Process diagrams, block flow diagrams, P&IDs, process units symbology, stream numbering and drawings, basic control loop, instrumentation symbology, developing PFD for various bioprocesses, Process economics, Capital cost, operating cost estimation, profitability analysis, Case studies: Citric acid production, process description, flow sheet, and economic evaluation.

Course Learning Outcomes (CLO):

Students will be able to

1. comprehend the important mechanical aspects while designing a bioprocess equipment.
2. compare the design considerations of various types of bioreactor.
3. evaluate the effect of process variables on bioreactor performance while scaling up
4. recognize and choose suitable P&I symbols used in P&IDs for the bioprocess plant design.

Text books

1. L. E. Brownell and E. H. Young- *Process Equipment Design*, Wiley India Pvt. Ltd. (2015)
2. M.V. Joshi and V.V. Mahajani- *Process Equipment Design*, MacMillan Company of India Ltd.(2009)
3. R. K. Sinnott- *Chemical Engineering Series: An Introduction to Chemical Engineering Design (Vol. 6)*, , Maxwell Macmillan Pergamon Publishing Corporation (2005)

Reference Books

1. K. Van't Riet and J. Tramper-*Basic Bioreactor Design* , Taylor & Francis Inc, New York, United States (1991)

2. *Max Peters & Klans D Timmerhauss-Plant Design & Economics for Chemical Engineers", 4th Edition; Mc Graw Hill Book Co (1991)*
3. *Tapabrata Panda-Bioreactors Analysis and Design, Tata McGraw Hill Education Pvt. Ltd, (2011)*

Evaluation Scheme:

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

UBT835: DRUG DESIGN AND DEVELOPMENT

L	T	P	Cr
3	1	0	3.5

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.

Detail contents

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).

Course Learning Outcomes (CLO):

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	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UBT836: CANCER BIOLOGY AND INFECTIOUS DISEASES

L	T	P	Cr
3	1	0	3.5

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

Detail contents:

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

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 tumour 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, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection.

Viral disease: Life cycle and pathogenesis, Mode of transmission, Clinical course, disease burden, risk factors, epidemiology, prevention, and treatment (Influenza, Dengue, Ebola, HIV, Hepatitis, Polio and Rotavirus). Role of papilloma, HIV, Epstein Barr Virus, HTLV and herpes in pathogenesis of cancers, diagnosis and prevention.

Bacterial disease: Pathogenesis, Mode of transmission, Clinical course, disease burden, risk factors, epidemiology, prevention, and treatment (Bacteria causing Tuberculosis, Pneumonia, Cholera, Typhoid and Diphtheria).

Course Learning Outcomes (CLO):

Students will be able to

1. comprehend pathogenesis, molecular mechanisms and identification of cancer
2. explain cancer metastasis microenvironment and cancer therapy
3. explain pathogenesis of bacterial and viral disease and its treatment.

Text books

1. Sverre Heim, Felix, Mitelman. *Cancer Cytogenetics 3rd Edition* Willy- Blackwell 2011.
2. Robin Hesketh. *Introduction to Cancer Biology* Cambridge, University Press 2013.
3. Fred Bunz. *Principles of Cancer Genetics*, Springer; 2008 edition
4. Edward K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini, *Basic Virology 3rd edition*, Wiley-Blackwell 2007.
5. Eduardo Groisman, *Principles of Bacterial Pathogenesis* Academic Press, 2001

Reference Books

1. *An Introduction Top Cellular And Molecular Biology of Cancer*”, j Oxford Medical Publications, 1991.
2. *Stella Pelengaris and Michael Khan. The Molecular Biology of Cancer, 2nd edition. Wiley Blackwell, 2013*
3. *Samuel Baron, Medical microbiology, 4th edition University of Texas Medical Branch at Galveston; 1996.*

Evaluation Scheme:

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

Elective III
UBT823: GENOMICS AND PROTEOMICS

L T P Cr
3 0 2 4.0

Course Objective: To understand the concept of genomics and its relevance to biotechnology. The course aims to make Students know about various components of genome and to compare genomes of organisms of different phylogenetic lineages. The objectives also include knowledge of transcriptomics and proteomics and their applications. In addition, they will learn about methods of studying genetic materials obtained from various environmental samples.

Detail contents:

Genomes - structure and organization: Genome size variation among different phyla, repeat and complex sequences, coding regions and open reading frames, GC content, re-association kinetics, gene density in prokaryotic and eukaryotic genomes and gene structures.

Genome sequencing: Genome mapping, sequence tags, RFLP, RAPD, SNP, padlock probes, radiation hybrid mapping, HAPPY mapping. Sequencing genomes using high throughput sequencing techniques, clone-by-clone and, whole genome shot gun approach, quality of genome sequence. Human genome sequencing project.

Comparative genomics: Comparative genomics of bacteria, eukaryotes and organellar genomes, horizontal gene transfer phenomena. Evolution of genomes and applications of comparative genomics.

Transcriptomics: Differential gene expression and its importance, SAGE and EST analysis, printed arrays, DNA microarray technology and oligonucleotide arrays, microarray data analysis, RT-PCR, applications of transcriptomics.

Metagenomics: Introduction to metagenomics, microbial communities and their importance, designing a metagenomic project, habitat selection, sampling strategy, macromolecular recovery, 16S rRNA based analysis, examples of metagenomics projects

Proteomics: Proteomics Technologies - Protein Arrays, Protein Chips and their application, 2D Gel Electrophoresis and its application, Mass Spectrometry and Protein identification, Shotgun proteomics, Role of Bioinformatics in Proteomics, Proteomics Databases, Protein-Protein Interactions - Concepts and Databases, Proteomics Analysis Tools at ExPaSy , Applications of Proteomics in Life Sciences.

Laboratory work: Comparison of genomes, comparison of introns in higher eukaryotes, CpG islands, ORFs, SNPs, RAPD, ESTs & STS, Proteomics tools, Structural and functional predictions, Phylogenetic analysis

Course Learning Outcomes (CLO):

Students will be able to

1. explain the properties of genetic materials and storage and processing of genetic information.
2. analyze genomic data.
3. explain biological phenomena based on comparative genomics

4. design transcriptomics and proteomics experiments for studying differential gene expression and related analysis
5. use metagenomic approach for studying phenomena associated with microbial communities.

Text 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. *Lesk, A. M., Introduction to Genomics, Oxford University Press (2008), ISBN 978-0-19-955748-6*
3. *Lesk, A. M., Introduction to Bioinformatics (3rd Edition), Oxford University Press (2011), ISBN 978-0-19-958079-8*
4. *Ghosh, Z. and Mallick, B., Bioinformatics Principles and Applications(2008) Oxford University Press ISBN 9780195692303*

Reference Books

1. *Lewin, B., Genes VIII, International Edition, Pearson Education International (2004), ISBN 0131238264*

Evaluation Scheme:

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

UBT841: MOLECULAR DIAGNOSTICS

L	T	P	Cr
3	0	2	4.0

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.

Detail contents

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: Dermatophytoses, 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: Amoebiasis, Malaria, Trypanosomiasis, Leishmaniasis. Study of helminthic 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 -Ultrasoundography, 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.

Laboratory: Identification of human bacterial pathogens by Polymerase chain reaction, Detection of viral infections in shrimp by PCR, Genotypic characterization of fungal pathogen, Molecular diagnosis of parasitic disease, Amplification of Short Tandem Repeats (STR)/Microsatellites, Multiplex STR PCR Single strand conformation polymorphism (SSCP) analysis.

Course Learning Outcomes (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

References

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. Sahn, Alice S. Weissfel Ernest A. Trevino, Published by C.V. Mosby

Evaluation Scheme:

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

UBT842: ADVANCES IN FOOD TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To impart knowledge about the innovations in food processing technologies and their applications. To understand changes in the composition of food and comparison with conventional cooking methods. To know packaging materials, their need according to different foods and to food quality parameters and their maintenance during storage.

Detail contents:

Innovation in food processing technologies: Need for Advances in food processing technologies, Membrane technology, Supercritical fluid extraction, Microwave processing, Hurdle technology, Freeze Drying, High Pressure processing, Ultrasonic processing, Pulse Electric, Ohmic heating, Infra-red technology, Induction heating, Air frying/cooking technology, Ozone technology, Halogen lamp cooking, pulsed X-rays in food processing and preservation. Principles and applications of nanotechnology in food sector.

Extrusion Technology: Objectives and importance of extrusion in food product development; Components and functions of an extruder; Classification of extruder; Advantages and disadvantages of different types of extrusion; Change of functional properties of food components during extrusion; Pre and post extrusion treatments; Manufacturing process of extruded products; Application of extrusion technologies in food industries. Quality testing of extruded products.

Packaging and Storing: Packaging material and their selection –paper, polymers, glass, metals etc., Types and levels of packaging, novel packaging techniques, Oxygen, ethylene and CO₂ scavenging technology, constructing of antimicrobial food packaging system, Novel MAP applications for fresh-prepared produce, Novel MAP gases and testing their applications, Application of high O₂ MAP, Zero Energy chamber, Hypobaric storage etc.

Utilization of by-products from food industry: Major types and usage of by-products from cereals, fruits and vegetables, dairy, meat, poultry, fish, oilseeds, plantation crops like tea and coffee processing industries, their composition and application in new product development. Food waste, types and generation from various sources, recycling and management.

Food Quality and maintenance: Food quality, different factors inside and outside the food, Objective and subjective evaluation of food quality, analytical instruments used in food analysis, their working and principle. Maintenance of quality through mandatory and voluntary standards; their working set up and application in foods.

Food Security: Reviewing the global food situation with emphasis on Food security, Nutritional security, Factors influencing nutritional security, Causes of food insecurity and solution in India as well as around the world.

Course Learning Outcomes (CLO):

Students will be able to

1. explain need and various applications of innovative food processing technologies, principle with advantages and disadvantages.
2. compare the requirements of extrusion cooking and the conventional cooking and changes in food.
3. explain importance of packaging in food as per food requirement and food designing.
4. utilize different food wastes with specific composition for different value added products.
5. explain food quality and its maintenance as per specifications of standards and food laws.

Textbooks

1. *M. Shafiur Rahman (2007) Handbook of food preservation, 2nd edition, CRC Press, Taylor & Francis Group, NW.*
2. *Richard Coles, Derek McDowell and Mark J. Kirwan (2004), Food Packaging Technology, CRC Press, Blackwell publishing ltd.*
3. *By: Mridula D. & M.R. Manikantan (2012) Food Processing Technologies, Co - Product Utilization and Quality Assurance, Satish Serial Publishing House.*
4. *N.D Frame (2004) The Technology of Extrusion Cooking, Published by Blackie Academic & Professional, Glasgow, NZ*

Reference Books

1. *Avantina Sharma (2006)-Textbook of Food Science & Technology, International Book Distributing Company, 1st ed.*
2. *Avantina Sharma (2010)-Textbook of Food Science & Technology, International Book Distributing Company, 2nd ed.*

Evaluation Scheme:

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

UBT591: SUMMER TRAINING

L T P Cr
0 0 0 4.0

Course objective: The purpose of this training is to provide exposure to the working environment of various industries and research institution. During this period, the Students will get hands on training in the diverse areas of biotechnology.

Scope of training: The Students will get an opportunity to know the ongoing R&D activities in different industries, institutes and universities. The Students will explore and gain experience in different branches of biotechnology viz agriculture, food, medicine and pharmaceutical. The Students will develop understanding of biosafety, bioethic, regulatory and compliances. Therefore, the summer training programme will help Students to identify the areas of their interest. Moreover, the Students will know how to write, analyze and compile data, and present the technical/scientific report.

Course Learning Outcomes (CLO):

The Students will be able to:

1. adapt to the varying working environment in industry and research institute
2. design experiments pertaining to different areas of biotechnology
3. analyze and interpret the experimental data
4. communicate the scientific data/outcomes to the peers

UBT793: PROJECT SEMESTER

L T P Cr
0 0 0 20.0

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, bioethic, 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.

Course Learning Outcomes (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:

S.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
4.	Presentation cum viva	30

UBT891: CAPSTONE PROJECT

L	T	P	Cr
0	0	2	8.0

Course Objectives: 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.

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.

Course Learning Outcomes (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: Evaluation of the project will be based on following components.

Evaluation Elements	Weightage (%)
Formulation of the problem and objectives	10
Execution of the project	20
Results and data interpretation	20
Technical report	20
Presentation cum viva	30