B Tech Course Structure 2017-18 Biotechnology

JES					
4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch					
		BTech I semester (B1)			
SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Presentation and Communication Skills	3	3	
2	MA	Basic Math-I/ OR	4	4	
	BT	Fundamental Biology	3	3	
3	PH	Basic Engineering & Applied Physics	4	4	
4	BT	Cell Biology	4	4	
5	CI	Introduction to Computers and Basic Programing	4	4	
6	PH	Physics Lab-1	2	1	
7	BT	Cell Biology Lab	2	1	
8	BT	GLP and Instrumentation Lab	4	2	
9	CI	Basic Computer Programming Lab	4	2	
	BT	Fundamental Biology Lab	2	1	
		Total	31	25	
	PD	English* (*This subject will be offered as an audit course for students with less than 60% marks)			

JES					
4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch					
		BTech II semester (B2)			
SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Group and Cooperative Processes	3	3	
2	MA	Basic Math-II	4	4	
3	BT	Genetics	4	4	
4	1BT	General Chemistry	4	4	
5	CI	Basic Data Structures	4	4	
6	BT	Genetics Lab	4	2	
7	BT	Chemistry Lab	2	1	

8	CI	Basic Data Structures & Computer Programming Lab	4	2	
		Total	29	24	

JES

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

		BTech III semester (B3)			
SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Managerial Economics	3	3	
2	MA	Probability & Statistics	4	4	
3	BT	Thermodynamics & Chemical Processes	4	4	
4	BT	Biochemistry	4	4	
5	BT	Microbiology	4	4	
		Thermodynamics & Chemical Processes Lab	2	1	
7	BT	Biochemistry Lab	4	2	
8	BT	Microbiology Lab	4	2	
		Total	29	24	

JES

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

		BTech IV semester (B4)			
SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Financial Management	3	3	
2	BT	Cell Culture Technology	4	4	
3	EC	Basic Electronics	4	4	
4	PH	Biophysical Techniques	4	4	
5	BT	Molecular Biology	4	4	
7	GE	Environmental Studies	3	3	
8	BT	Molecular Biology Lab	4	2	
9	BT	Animal Tissue Culture Lab	2	1	
10	BT	Plant Tissue Culture Lab	2	1	
11	EC	Basic Electronics Lab	2	1	
		Total	32	27	

JES

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

BTech V semester (B5)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Social & Legal Issues	3	3	
2	BI	Elective course from Bioinformatics	4	4	
3	BT	Bioprocess Engineering	4	4	
4	BT	Genetic Engineering	4	4	
5	BT	Immunology	4	4	
6	BT	Bioinformatics Lab	2	1	
7	BT	Bioprocess Engineering Lab	4	2	
8	BT	Genetic Engineering Lab	4	2	
9	BT	Immunology Lab	2	1	
10.		Minor Project-I		2	
		Total	31	27	

JES

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

BTech VI semester (B6)

SN	Sub Code	Subject	Contact hours	Credits	Remarks
1	PD	Project Management/Open Elective	3	3	
2	BT	Comparative and Functional genomics	4	4	
3	BT	Food and Agricultural Biotechnology	4	4	
4	BT	Downstream Processing	4	4	
5	BT	Diagnostics & Vaccine Manufacture Technologies	4	4	
6	BT	Comparative and Functional Genomics Lab	4	2	
7	BT	Food and Agricultural Biotechnology Lab	4	2	
8	BT	Downstream Processing Lab.	4	2	
9	BT	Diagnostics & Vaccine Manufacture Technologies Lab	2	1	
10	GE	Industrial Training		0	

		Minor Project-II		2	
		Total	33	28	

JES

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

		BTech VII semester (B7)			
SN	Sub Code	Subject	Contact hours	Credits	Remarks
1		Professional Dev – VII/Open Elective/Moocs	3	3	
2		DE-I	3	3	
3		DE-II	3	3	
4		DE-III	3	3	
5	BT	Project Part I	16	8	
		Total	28	20	

JES

4 year BTech New Approved Curricula for Biotechnology wef 2017-18 batch

		BTech VIII semester (B8)			
SN	Sub Code	Subject	Contact hours	Credits	Remarks
1.		Professional Dev – VIII Open Elective/Moocs	3	3	
2.		DE-IV	3	3	
3.		DE-V	3	3	
4.		DE-VI	3	3	
	BI	Project Part-II	16	8	
		Total	28	20	
		Total Credits in B.Tech.Bioinformatics		195	
		List of Electives			
		(To be updated from time to time)			
		MEDICAL			

	BT	Antibody Engineering Technologies			
	BT	Stem Cells & Regenerative Medicine			
	BT	Vaccine Production			
		FOOD AND AGRICULTURE			
	BT	Fermented Food Products Technology			
	BT	Food Processing & Engineering			
	BT	Industrial Plant Tissue Culture			
	BT	Plant Biotechnology			
	BT	Traditional Bioprocesses			
		INDUSTRIAL			
	BT	Bioenergy and Biofuels			
	BT	Bioprocess Modelling and Simulation			
	BT	Bioprocess Optimization & Upscaling			
	BT	Bio-resources & Industrial Products			
	BT	Environmental Biotechnology			
	BT	Manufacturing Processes & QC			
	BT	Nano Biotechnology			
	BT	QC Analysis & Management			
		OTHERS			
	PH	Biosensors			
	PH	Nanoscience & Nanotechnology			
	BT	IPR and Bioethics			
		Credit Summary	Credits		
		Sem1	25		
		Sem2	24		
		Sem3	24		
		Sem4	27		
		Sem5	27		
		Sem6	28		
		Sem7	20		
		Sem8	20		
		Total	195		

Fundamental Biology (*Core Course*13B11BT111)

(B.Tech, Sem I) Credits 3

Lectures 3 Tutorial 0 Practical 1

Pre-requisites: X^{th} class general biology

Course Objectives (Learning Goal):

This is basic foundation biology course for the students having mathematics background.The objectives are to familiarize students with basics of biology and different kingdoms, their characteristics, and different biomolecules such as carbohydrates, lipids, proteins. The course is also designed to familiarize the students with the various biological processes at molecular level like replication, transcription and translation.

Course Assessment:

Test 1	15
Test 2	25
Test 2	35
Teacher Assessment (Based on Assignments, quizzes etc.)	25
Total	100

Course Outcomes:

CO I: After this course completion, students coming from mathematics background Would have fundamental knowledge of the organism.

CO II: Students should able to understand the characteristics of an organism and their Importance in Biotechnology

CO III: Students will have basic knowledge of DNA, RNA, Protein, Carbohydrate and Proteins

Course Outline

S. No.	Unit		No. of

			Lectures
1.	Biological systems and their organizations:	Overview of living system and their different life forms, Plants, animals and micro-organisms: their similarities and differences	2
		Basic biological processes, hierarchy of living system from individual to molecular level. Cells and their organizations, basics of cell membrane	3
2.	BIOMOLECULES: Building blocks of living system	Carbohydrates: Chemical structures, nature, properties, Classification and Importance in Biological Systems.	3
		Lipids: Structure, Classification, Properties and Function.	3
		Amino acids and Proteins: Structure properties, classification, and function.	4
		Enzymes: Classification, Characteristics	2
		Nucleic acids: Nitrogenous bases, nucleosides and nucleotides, DNA & RNA structures, rRNA, tRNA and mRNA.	4
3.	BIOLOGICAL CLASSIFICATION:Five Kingdom Classification	Taxonomy based classification overview: Merits and demerits, Characteristics of the Five Different Kingdoms	1
		KINGDOM MONERA: Archaebacteria and Eubacteria. Basic biology of different bacteria of different shapes,	2
		KINGDOM PROTISTA: Chrysophytes, Dinoflagellates, Euglenoids, Slime Moulds, Protozoans	1
		KINGDOM FUNGI: Different classes of fungi with life cycles. Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes,	2
		KINGDOM PLANTAE: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms, Plant Life Cycles and Alternation of Generations	2
		Kingdom Animalia: Basis of classification, Level of organization	2

		and their Classification. Basic life functions of humans	
4	Flow of information in biological system	Central Dogma, DNA replication and Transcription	4
		Translation, initiation, elongation and termination.	2
5	Molecular details of Biological processes	Overview of metabolism	1
		Molecular respiration and energy production.	3
6	Biology and Bioinformatics	Role of above mentioned processes and structure in Bioinformatics	1
		Total	42

Methodology

The course will be taught through lectures. Apart from the discussions on the topics covered in the lectures, presentations, assignments in the form of questionnaires will also be given.

Internal Assessment

Assessment	Marks
Quiz/presentations	15
Assignment	5
Attendance	5
TOTAL	25

Suggested text book:

1. Neill, Campbell (1996). Biology; Fourth edition.The Benjamin/Cummings Publishing Company. p. 309,310. ISBN 0-8053-1940-9.

2. Stryer, Lubert (2002). Biochemistry; Fifth edition. W. H. Freeman and Company.

3. Principles of Biochemistry [5th edition], Lehninger.pdf

4.ARTHUR W. HAUPT, Fundamental of Biology, 3rd ed. McGRAW-HILL

B. Tech 1st year (Biotechnology/Bioinformatics)

Course: Fundamental Biology lab.

Course Code: 13B17BI171

Course Credits: 1

Pre-requisites: This lab course is designed for those students who didn't have biology in class XII and this course would give the foundation for biotechnology and bioiformatics.

Objective:
The objective of this course is to familiarize the students with basic biology laboratory techniques specifically used in modern biotechnology area.

Course Assessment:

Mid Term Test	20
End Term Test	20
Day to Day Performance: Attendence Quantity & Quality of Experiments including Performed, Learning laboratory Skills and handling Laboratory Equipment, Instruments, Gadgets, Components, Materials and Software etc. Laboratory record	60 15 30 15
Total	100

Course Outcomes:

CO I: Student coming from mathmetics background would have fundamental knowledge of The organism used in the various experiment.
CO II: Student should able to understand the characteristics of an organism and their Importance in biotechnology
CO III: student will have basic knowledge of equipment used in laboratory experience

5	To prepare a smear of bacterial culture.	17-18
6	Serial dilution of bacterial culture	19
7	Introduction to simple and differential staining (gram staining)	20-22
8	Staining of unicellular eukaryote	23-24
9	Microscopic examination of Algae (chlorella)	25
10	Microscopic examination of fungi	26-27
11	Measurement of concentration of a given solution. (Calculation of Molarity, Normality & Molality)	28
12	Calibration of pH meter and adjustment of pH of given solution	29
13.	To prepare a temporary mount of onion cell	30
14	Introduction to spectrophotometers	31-32
15	Preparetion of standard curve	33-35

Methodology: Students will do various experiments in Undergraduate lab
Reference books and related material:

1. Lab manual
2. Laboratory exercises in Microbiology – Harley Prescott
3. Biotechnology Lab Course: Jeffery M.Becker, Guy A. Caldwell, Eve Ann Zachgo
4. Biology 6th edition : Raven - Johnson

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13B11BT112 **Cell Biology** *Core Course*
Credits 4

Lectures 3 Tutorial 1

Pre-requisites, if any Basic Biology and introductory chemistry.

Introduction:
Cell biology is the study of the structure and function of prokaryotic and eukaryotic cells. The course would cover many different areas of cellular biology including: the synthesis and function of macromolecules such as DNA, RNA, and proteins; control of gene expression; membrane and organelle structure and function; bioenergetics; and cellular communication. Ex. of relevant human disorders will be correlated for student's understanding.

Course Objectives (Learning Goals):

To understand fundamental concepts of what life is and how it functions at the cellular level.

Learning Outcomes

- Successful student will understand fundamental concepts of cellular function.
- Be able to critically analyze, the scientific evidence underlying current understanding of cellular processes.
- To be able to correlate cellular processes with forthcoming subjects such as biochemistry, genetics, cell culture, etc.
- To be able to put this knowledge into larger contexts of how disease states occur or how organisms function adaptively within their environments.

Course Assessment:

Test -1	15
Test -2	25
Test -3	35
Teacher Assessment (Based on Assignments, quizzes, Attendance, etc.)	25
Total	100

Topics covered (Total 42 Lectures)

SNo	Topic		No of Lectures
1	Introduction to the cell	Prokaryotic and Eukaryotic cell; Animal and Plant cell, Cell and genomes, cell chemistry and biosynthesis, proteins	6
2	Basic genetic mechanisms	DNA and Chromosomes, DNA replication, repair and recombination, how cell read the genome: from DNA to protein, Control of gene expression.	7
3	Internal organization of the cell	Membrane structure, Membrane Transport of Small Molecules and the Electrical Properties of Membranes, Intracellular Compartments and Protein Sorting, Intracellular Vesicular Traffic,	8
		Energy Conversion: Mitochondria and Chloroplasts, Cell Communication, The Cytoskeleton, The Cell Cycle and Programmed Cell Death, The Mechanics of Cell Division	6
4	Cells in their social context	Cell Junctions, Cell Adhesion, and the Extracellular Matrix, Germ Cells and Fertilization, Development of Multicellular Organisms, Histology: The Lives and Deaths of Cells in Tissues,	7
		Cancer, The Adaptive Immune System, Pathogens, Infection, and Innate Immunity	5
5	Methods and techniques	Manipulating proteins, DNA and RNA. Visualizing cells.	3

Assignments on topics:

1. Prepare a chart to list different types of cells with a neat sketch.

Quizzes:

There will be two quizzes with each of 10 marks. Quizzes will have short answer type, MCQ or/and fill in the blanks. September and November.

Suggested Reading:

1. Molecular Biology of the Cell: by Bruce Alberts, 4th Edition 2002.
2. Lodish, et al. *Molecular Cell Biology*. 5th ed. New York, NY: W.H. Freeman and Company, 2003.

13B17BT172 **Cell Biology Lab** *Core Course*

Credits 2

Lectures 0 Tutorial 0 Practical 4

Pre-requisites, if any Basic Biology and introductory chemistry.

Introduction:

Cell biology is the study of the structure and function of prokaryotic and eukaryotic cells. The course would cover many different areas of cellular biology including: the synthesis and function of macromolecules such as DNA, RNA, and proteins; control of gene expression; membrane and organelle structure and function; bioenergetics; and cellular communication. Ex. of relevant human disorders will be correlated for student's understanding. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in cell and molecular biology research.

Course Objectives (Learning Goals):

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

Learning Outcomes

Successful students will be:

- Able to identify different cell types, cellular structures using different microscopic techniques.
- Able to count, analyze the size of cells and differentially stain & observe cellular organelles.
- Able to understand and demonstrate cellular phenomena.

Course Assessment:

Mid Term Viva	20
End Term Exam	20
Teacher Assessment (Based on Day to day performance, lab notebook, attendance, assignment, etc.)	60
Total	100

Topics covered (Total 14 Experiments)

1. Laboratory Safety
2. To Study various parts of compound microscope
3. To prepare temporary slides and differentiate the plant cells and animal cells
4. To learn the use of micrometer to measure the size of a given cell sample
5. To observe and classify the prokaryotic cells (bacteria) using differential staining
6. To study the effect of salinity on biological membranes of cells

7. To study the permanent microscopic slides of mitosis
8. To study the permanent microscopic slides of meiosis
9. To prepare permanent microscopic slides of stem and root cells/sections
10. To prepare permanent microscopic slides of liver/heart sections of rodents
11. To prepare the blood smear slides and visualization of the components of blood using light microscopy
12. To perform RBC count using haemocytometer
13. To observe and differential identification of lymphocytes using giemsa staining
14. Staining of nucleic acid by acetocarmine
15. To separate nucleus, cytoplasm and membrane fraction of cells/tissue
16. To isolate plasma, serum and RBCs from blood sample.

GLP Instrumentation Processes Lab

13B17BT173 Core Course

Credits: 2

L 0 T 0 P 4

Pre-requisites: None

Course Objectives:

1. To make the students familiar with the safety precautions and handling of elemental lab instruments and to make them familiar to the lab environment.

2. A preparatory lab course to make the students learn guidelines and precautions for carrying out basic experiments in biotechnology.

Course Assessment:

Mid Term Lab & Viva (P1)	20
Teacher Assessment based on Day to day performance(P3) 1. Attendance and discipline (15) 2. Performance in day to day experiment/activity(30) 3. Laboratory record (15)	60
End Term Lab Exam (P2)	20
Total	100

Course Outcomes:

CO I: Students would know about general safety precautions, etiquette and PPE required for any biotechnology experiment.

CO II: Students would have hands-on practice and experience with basic instruments, for easy and swift conductance of labs in forthcoming semesters.

Topics covered:

1. Introduction to Laboratory Safety – Chemical, Biological
2. Guidelines for Good Lab practices, SOPs
3. Handling and practice of pipettes – glass, micropipette
4. Handling of weighing balance, mole calculation
5. Introduction to Incubators, Shakers, Water Bath and Ovens
6. Autoclaving – principles and handling; Concept of Decontamination
7. Introduction to lypholizer, rotary evaporator
8. Handling of Microscopes
9. Principle and Working of pH meter
10. Preparation of solutions and buffers
11. Introduction to chromatography techniques - TLC, paper
12. Biological safety cabinets & Culture room etiquettes
13. Introduction to various types of lab spectrophotometers
14. Preservation Techniques – principles, utility of short and long term preservation
15. Introduction and handling of centrifuges
16. Agarose gel electrophoresis – principle and handling

Text books

1. Lab manual
2. GLP Essentials: a Concise Guide to Good Laboratory Practices Milton. A. Anderson (2002)
3. Good Laboratory Practice Regulations / Edited by Sandy Weinberg (2007)
4. Good Laboratory Practice: the why and the how / Jurg P. Seiler (2005)
5. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker (2009)

Course: GENETICS

Subject Code:10B11BT411 Number of credits: (3-1-0) 4

Course Coordinator: Dr. Sudhir Kumar

Pre-requisites: Basic Biology

Course Objectives (Learning Goal):

Genetics is a core course designed to cover both basic and advanced concepts in classical genetics. A good understanding on this subject will help the students to think analytically on other areas of modern biology and medicine. After completing this course the students would acquire a good understanding of Mendelian analysis, linkage analysis, gene mutation and genetics of model organisms, cancer genetics and population genetics.

Course Outcomes:

CO I. Students will combine their knowledge of probability theory with the rules of inheritance to do pedigree analysis and accurately predict genetic outcomes. Additionally students will be able to interpret pedigrees and phenotypic ratios to determine if genes are autosomal or sex-linked, linked or sorting independently, and genotypes of parents.

CO II. Students will develop an appreciation of how genes work within organisms and they will be able to recognize real-world examples of genetics topics and demonstrate the interaction of genetics in society.

S.No.	Topics	No. of lectures
1	Introduction to Genetics	2
2	Cell Division (mitosis and meiosis) Basic principles of Mendelian experiments Mendel's laws and its extension	6
3	Chromosomes and Chromosome theory of inheritance Chromosomes, Chromosomal abnormalities: polyploidy, Lampbrush and Polytene chromosomes, The Chromosome Theory of Heredity, Sex Chromosomes and Sex- Linkage	6
4	Gene interaction Genes, Alleles, Lethal alleles, Multiple alleles and their interaction, Pleiotropism, Penetrance and expressivity	4

5	Linkage and chromosome mapping The Discovery of Linkage,Linkage and Recombination, Linkage of Genes on the X- chromosome, Linkage maps, Three-Point Testcross, Interference, Calculating Recombinant Frequencies, Examples of Linkage Maps, Chi-square test, The Nature of Crossing-Over, Linkage Mapping by Recombination in Humans.	6
6	Gene mutation	6
	Somatic versus germinal Mutation, Mutant Types, Mutation Induction, Gene Mutation, The Molecular Basis of Gene Mutations, Spontaneous Mutations, Induced Mutations, Reversion Analysis, The Relationship between Mutagens and Carcinogens	
7	Extra Chromosomal Inheritance Extra nuclear Inheritance in Higher Plants, Overview of the Mitochondrial Genome, Overview of the Chloroplast Genome	5
8	Population Genetics Darwin's Revolution, Variation and Its Modulation, The Effect of Sexual Reproduction on Variation, The Sources of Variation, Selection, balanced Polymorphism, Quantitative genetics.	7
	Total	42

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Evaluation scheme:

T1	1 hour	15 (course covered upto T1)
T2	1.5 hour	25 (course covered upto T2, including that covered upto T1)
T3	2 hours	35 (total syllabus)

Tutorials, quiz, and home assignments

25 Total 100

Text books:

1. Concept of genetics by William S Klug and M.R. Cummings
2. Principles of Genetics. D P Snustad, M J Simmons

Reference books:

1. An Introduction to Genetic Analysis. Griffiths et al.
2. Genetics, from Genes to Genomes L.H. Hartwell et al,
3. Genetics by Strickberger
4. Genetics by Peter J. Russell
5. Principles of Population Genetics by Daniel L. Hartl and Andrew G. Clark

Genetics Lab

10B17BT372 Core Course

Credits: 2

L 0 T 0 P 4

Pre-requisites: Basic Biology

Course Objectives (Learning Goal):

Genetics is a core course designed to cover both basic and advanced concepts in classical genetics. A good understanding on this subject will help the students to think analytically on other areas of modern biology and medicine.

Course Assessment:

Mid Semester Evaluation Test	20
End Term Test	20
Teacher Assessment (Based on day-to-day work, practical file, etc)	60
Total	100

Course Outcomes:

CO I. Correctly analyze and interpret experimental results within the limitations of the experimental design

CO II. Obtain hands-on experience in performing fundamental genetics experiment, including working safely and efficiently in a modern laboratory setting

CO III. Understand the statistical analysis of genetic data relevant to forensic, conservation and evolutionary genetics, and summarize and interpret the outcomes.

Topics covered:

1. Course orientation and Lab safety, Microscopy and slide study of Mitosis permanent slides.
2. To study the various stages of cell division and calculate the mitotic index using onion root tips. Students are also free to choose/design their own experiment of Mitosis using any feasible biological sample
3. Study of co-dominance using ABO and Rh blood typing
4. Handling Drosophila, identifying mutants, and scoring flies
5. Drosophila genetics and recombination
6. Analysis of drosophila recombinants using probability and Chi-Square test.
7. Genetical studies to understand recessive, dominant and co dominant phenotypes
8. Bacterial genetics and conjugation studies
9. Survey of DNA polymorphism using Dominant and Co-dominant molecular markers (RAPD,ISSR and SSR)
10. Understanding population and evolutionary genetics using in silico techniques

Text books

Lab manual and Practical Genetics

General Chemistry

14B11BT211

Core Course
Credits: 4
L 3 T 1 P 0

Pre-requisites: XIITH Standard Chemistry

Course Objectives (Learning Goal):

1. The objective of this course is to provide the chemistry foundation required for understanding the various processes involved in biological system.

2. Course Assessment:

T-1 Test	15
T-2 Test	25
T-3 Test	35
Teacher Assessment (Based on Assignments, quizzes etc.)	25
Total	100

Course Outcomes:

CO I: Able to discuss the fundamental chemistry of elements of biological importance and their significance to biological processes and able to describe organic reaction mechanisms that impact on biochemical processes.

CO II: Able to recall the characteristics of important bio-molecules and be able to discuss the relationships between structure properties and functions

CO III: Able to design experiments and to use appropriate experimental apparatus effectively and ability to read, evaluate and interpret numerical, chemical and general scientific information

Topics covered:

Atomic and molecular structure Chemical bonding, molecular shape and structures, Acid-base chemistry & resonance, pH, buffer solution, Acid base titration, redox titration, Introduction of chemical thermodyanamics, reaction kinetics, Chemical equilibrium and aqueous equilibria, Organic Functional group and their nomenclature, Stereochemistry of organic compounds, optical activity; stereoisomerism; specifications of configurations. Bayers strain theory Cyclo hexane and its confirmation, mechanism of organic reaction, Reactions and synthesis of organic compounds such as Alkanes, Alkenes, alkynes, alcohols, ethers, epoxide, aldehydes, ketones, enols, enones, carboxylic acid, and aromaticity, Chemistry of carboxylic acid and their derivatives, Chemistry of Nitro group and amines, Co-ordination compounds and their biological importance, Chemistry of proteins and peptides, Nucleic acids, Carbohydrates and lipids, Chemistry of polymers

Text books

1.Robert Thornton Morrison, Robert Neilson Boyd, Saibal Kanti Bhattacharjee "Organic Chemistry" 7th ed., Pearson India, 2011

2.Jonathan Clayden, Nick Geeves, Stuart Warren, "Organic Chemistry" 2nd ed., Oxford University Press, 2012

3. J. D. LEE , "Concise Inorganic Chemistry" 5th ed., Wiley-Blackwell, 2004

Reference books

1. E.L. Eliel, "Stereochemistry of carbon compounds" 1st ed., Mcgraw-Hill Education, 2001

2. Jie Jack Li, "Name Reactions. A Collection of Detailed Reaction Mechanisms" 4th ed., Springer India Private Limited

3. Peter Sykes, "A Guide Book to Mechanism in Organic Chemistry" 6th ed., Prentice Hall

4. Peter Atkins, Julio De Paula, "Physical Chemistry for the Life Sciences" 2nd ed., W H Freeman & Co (Sd), 2011

General Chemistry Lab

14B17BT271

Core Course
Credits: 1
L 0 T 0 P 2

Pre-requisites: XIIth Standard practical chemistry

Objectives:

The objectives are to study

- To learn lab safety techniques, importance of personnel protective equipment and Enable students to link the theoretical knowledge of chemistry with the experiments.
- To learn identification of unknown organic compounds and their purification at small scale using chromatography and crystallization techniques.
- To learn how to perform assay of inorganic salts

Course Assessment:

Mid Term Viva and Test	20
End Term Examination	20
Teacher Assessment (Based on Day to Day performance in Experiments, lab notebook etc)	60
Total	100

Course Outcomes:

CO I: Able to apply practical knowledge to do identification of unknown compounds and synthesis of simple organic compounds

CO II: Able to purify organic compounds

CO III: Able to design experiments and analyze various data related to various practices in analytical chemistry

Topics Covered:

1. Lab safety techniques, importance of personnel protective equipment and introduction of chemical apparatus
2. Detection of extra elements (N,S,Cl,Br,I) in organic compounds (containing upto two extra elements)
3. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

a) Identify and separate the components of a given mixture of 2 amino acids (Glycine, Aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
b) Identify and separate the sugars present in the given mixture by paper chromatography.

4. Purification of organic compounds by crystallization (from water and alcohol).
5. To chemical identify following organic functional groups in given organic compounds
    a. Test for aldehydes, ketones, carboxylic acids and phenol
    b. Test for carbohydrates and amino acids
    c. Test for esters, nitro and amines (Primary amines, Secondary amines and tertiary amines)
6. To identify the extra element and functional group present in given unknown organic compounds
7. To prepare Oxime of 2,4 dinitrophenylhydrazone of aldehyde/ketone
8. To prepare Benzoyl derivative of amines/Phenols
9. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
10. Estimation of oxalic acid by titrating it with $KMnO_4$
11. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4
12. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$using internal indicator.
13. To identify the given unknown organic compounds.
14. Introduction to the use of stereo models

Text Books

1. A.I Vogel, "Elementary practical organic chemistry" 2nd ed., Prentice Hall 2006
2. A.I Vogel, "Elementary Practical Organic Chemistry: Preparations Pt. 2, 3rd ed., Prentice Hall

Reference books

1. D.L. Pavia G. Lampman and G.D. kriz, "Introduction to organic laboratory techniques"2nd ed., Brooks Cole 2004

Thermodynamics and chemical processes

10B11BT311

Core Course
Credits: 4
L 3 T 1 P 0

Pre-requisites: General Chemistry and Basic Physics

Course Objectives (Learning Goal):
To familiarize the student with the concept of thermodynamics, bioenergetics, Reaction kinetics, mass and energy balances as well as fluid flow mechanics and heat transfer.

Course Assessment:

T1 Exam	15
T2 Exam	25
T3 Exam	35
Teacher Assessment (Based on Assignments, quizzes etc.)	25
Total	100

Course Outcomes:
CO I: Use correct Thermodynamical terms to describe & analyze phenomena/problems in physico-chemical processes as well as in bioenergetics
CO II: Able to apply basic laws and principles in reaction kinetics under homogenous reactions.
CO III: Able to apply Material and Energy Balances in Systems Involving Biological Changes and Fluid flow mechanics as well as in different modes of heat transfer.

Module No.	Subtitle of the Module	Topics in the module	No. of Lectures for the module
1	Introduction and fundamental concepts of thermodynamics:	Processes, Components (single/multi), Phases (G/L/S), ideality, Concept of continuum for biological processes, Entropy, enthalpy, Gibbs Free energy, Specific heats /heat capacity. Laws of Thermodynamics and its applications.	3
2	Bioenergetics (Biological Thermodynamics)	Principles of bioenergetics. Energetics of metabolic pathways by metabolic flux, Energy coupling (ATP and NADH), Biological oxidation and reduction reactions. Understanding thequantitative relationships among free energy, enthalpy and entropy. Concept of Go, Go' to biochemical reactions, Endergonic and exergonic reactions, Catabolic and anabolic mechanisms.	5

3	Homogenoeus Reactions/Reaction kinetics	Basic reaction theory, Reaction Thermodynamics, Calculation of reaction rates from experimental data, General reaction kinetics for biological systems, Michaelis – Menten Kinetics, Kinetics of enzyme deactivation.	6
4	Material Balances of Biochemical Processes	Aspects of metabolic stoichiometry, principlesfor macroscopic analysis of cell growth and product formation. Calculation of nutrient and oxygen requirements during various fermentation processes. Analysis of batch culture of growing cells. Stochiometric coefficients for cell growth, Elemental and electron balances, Biomass yield, Product stochiometry, Theoretical oxygen demand, Thermodynamic maximum biomass and product yields.	7
5	Energy Balances of Biochemical Processes	Stochiometric and energetic analysis of cell growth and product formation, elemental study of energy flow within the living systems. Enthalpy calculations for reactive and nonreactive biological processes, Heat of reaction for the process of biomass production, Thermodynamics of microbial growth, Energy balance equation for aerobic and anaerobic cell culture and various other fermentation processes.	7
6	Fluid mechanics	Flow behavior of different fermentation fluids. Introduction, Classification of fluids, Newton's Law of viscosity, flow curves for Non- Newtonian fluids with examples from biotechnology, Reynolds number, Boundary layer separation, Fluids in motion, flow patterns– Laminar, turbulent and transition flow, Rheological properties of fermentations Broths, properties of Fluids (Viscosity, Surface Tension), Factors affecting broth viscosity, cell morphology.	7
7	Heat Transfer	Principles governing heat transfer with applications in bioprocess design. Modes of heat transfer, Heat - Transfer equipments. Analogy between Heat and momentum transfer, Heat transfer between fluids, Heat transfer coefficients, Design equations for heat transfer systems and its application.	7

Text Books:

1 Heat Thermodynamics and Statistical Physics: By B. Lal, N. Subramanyam and P. S. Hemne

2 Biochemistry : By Jeremy M. Berg, John L. Tymoczkao, L. Stryer;

3 Bioprocess Engineering Principles: By P.M. Doran.

Reference Books:

1 Thermodynamics: A Core Course By: R. C. Srivastava, S.K.Saha and A.K.Jain

2 Engineering Thermodynamics, By: Lynn D. Russsell and George A. Adebiyi

3 Lehninger's Principles of Biochemistry 4th Editoin : By D L Nelson, Cox Lehninger.

4 Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", 6th ed.
Prentice Hall of India, New Delhi, 1996

Thermodynamics and chemical processes Lab

10B17BT371

Lab Course
Credits: 1
L 0 T 0 P 1

Course Objectives (Learning Goal):
The students are to made familiar with the various experiments involved with the thermodynamics and chemical processes, calculation of thermodynamic parameters, reaction kinetics, Michael -Menton kinetics, flow of liquids using Ostwald viscometer, Stagmometer etc.

Course Assessment:

Mid Term Viva	20
End Term Viva	20
Lab Record (day to day basis) (Based on Recod, performance, Attendance etc.)	60
Total	100

Course Outcomes:
CO I: Able to familiar with the various experiments involved with the flow of heat
CO II: Able to correlate the chemical processes with reaction kinetics as well as Michael - Menton kinetics
CO III: Able to enhance practical skills related to all the measurements of fluid flow mechanics.

List of Experiments:

Exp. No.	Title of the experiment	Number of Lab required
1.	To determine Heat Capacity or Water equivalent of given thermos/ Dewar flask used as calorimeter	1
2.	To determine enthalpy/heat of solution of some biological important compound.	1
3.	To determine heat of neutralization of strong acid and strong base media	1
4.	Determination of the thermodynamic parameters: ΔH, ΔG, ΔS, and Cp of the protein lysozyme.	2
5.	To measure the energy in different food samples.	1
6.	To determine the activity of amylase by spectrophotometric method.	1
7.	To study the effect of different temperature on amylase activity.	1
8.	To study the effect of different pH on amylase activity.	1
9.	To calculate Km and Vmax of the amylase.	1
10.	To determine viscosities of various fluids: Glucose, Biological fluids and culture.	1

11.	To determine surface tension of various fluids: Glucose, Biological fluids and Culture.	1
12.	To study the flow pattern by changing the RPM	1

Reference Books:

1. Applied chemistry: Theory and Practice : By O.P. Vermani and A.K.Narula, Wiley Eastern Ltd.,
2. Lab Manual.

10B11BT312 BIOCHEMISTRY

(Core Course)

Credits 4

Lectures 3 Tutorials 1 Practical 0

Objective:

1. To provide an understanding of the basic bio-molecule structures, their origin and their involvement in life processes.
2. To provide an insight into the main metabolic pathways of living organisms and their integration with other biological pathways.

Course Assessment:

Exam	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-4
T2 Test	25	1.5 hrs.	Unit 1-8
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignment quizzes etc.)	25	Whole Semester(Quiz, sho presentations)	Inform class time time
Total	100		

Course Outcomes:

At the end of the course, the students will be acquainted with the metabolic functions of various bio-molecules and able to use physical and chemical principles to explain biochemistry at the molecular level.

Topics Covered:

	Unit	Modules	Hours
1	Bio-molecules	General introduction of structure, function & properties various bio-molecules of living organisms.	1
2	Carbohydrate	Mono-saccharides and their inter relationship, structure of sugar, Important derivatives of monosaccharide, disaccharides and trisaccharides. Biological importance of structural polysaccharides e.g. cellulose, chitin, agar, algenic acids, pectins, glycoproteins, proteoglycans, sialic acids, blood group polysaccharides, bacterial cell wall polysaccharides.	4
3	Lipids	Building block of lipids - fatty acids, glycerol, sphingosine. Definition and classification of lipids. Classification of fatty acids, physio-chemical properties of fatty acids, saponification and iodine number. Properties of glycerol, fats and oils. Properties and function of phospholipids and Prostaglandins. Structure of sterols with special reference to cholesterol. Role of Lipids in cellular architecture and functions.	4

4	Amino acids and Proteins	Classification of amino acids. Physical, chemical and opti properties of amino acids. Introduction to biologically active peptides e.g. Glutathione, Oxytocin, Insulin, basics of enzymes, Purification techniques and separation for proteins.	4
5	Nucleic acids:	General composition of nucleic acids, Importance of nucleic acids in living system, the purine and pyrimidine bases. Different types of DNA and RNA.	2
6	Carbohydrate Metabolism	Introduction to Intermediary metabolism, central role of glucose in metabolism of plants, animals. Glycolysis, reactions of glycolysis. Fermentation: anaerobic fate of pyruvate. Regulation of glycolytic pathway. Substrate cycle and their physiological importance. Overview of TCA, Metabolic sources of Acetyl-Coenzyme A. TCA Cycle inhibitors. Gluconeogenesis and its Regulation, Glyoxalate Cycle reactions. Glycogen metabolism, Synthesis and breakdown, glycogen synthetase and phosphoryllase and their regulation, Glycogen Storage diseases.	8
7	Lipid Metabolism	Biosynthesis of lipids, fatty acid synthesis and its regulation, biosynthesis of triacylglycerols, phospholipids, cardiolipids, glycolipids and sphingolipids. lipid digestion, absorption and transport. Fatty acids oxidation, oxidation of saturated, unsaturated fattys in mitochondria, transport of fatty acids to mitochondria. Ketone Bodies synthesis and degradation. Cholesterol metabolism in animals.	5
8	Amino Acids metabolism:	Overview; assimilation of inorganic nitrogen in biomolecules. Positive and negative nitrogen balance, Protein calorie malnutrition, Kwashiorkor and Marasmus. Glucogenic and ketogenic amino acids, catabolic pathways for the 20 standard amino acids; Metabolism of one-carbon units. Disorders of amino acid metabolism: Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Methylmalonic aciduria etc.	6
9	Purine a Pyrimidine metabolism	Biosynthesis of IMP; pathways from IMP to AMP and GMP; conversion to triphosphates; regulation of purine nucleotide biosynthesis, salvage pathways; synthesis of coenzymes (NAD+, FMN, FAD, HSCoA). Deoxy ribonucleotides and synthesis of dTTP; inhibitors of nucleotide metabolism and their use as anti bacterial / anticancer drugs. Degradation of purine and pyrimidine nucleotides. Disorders of nucleotide metabolism: Lesch Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency.	5
10	Vitamins	Structure of fat soluble vitamins A, D, E & K. Water soluble vitamins, their co- enzyme forms and deficiency disorders, Thiamine, riboflavin, pantothenic acid, niacin,	3

		pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.	

Books:

1. Lehninger Principles of Biochemistry Cox, M.M. and Nelson, D.L. and Lehninger A. L. 4th edition..
2. Biochemistry- J.M. Berg, J.L.Tymoczko, and Lubert Stryer; 5th edition W.H. Freeman and Company, New York, USA.
3. Voet, D. and Voet, J.G.(2011), 4th edition. Biochemistry, John Wiley & Sons, Inc. USA.
4. Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil Rodwell, (2012) 29th edition. Harper's Illustrated Biochemistry, Lange, McGrawHill.

BIOCHEMISTRY LAB

(Core Course 10B11BT372)
Credits 02

Lectures 0 Tutorials 0 Practical 12

Pre-requisites: Basic Chemistry and Cell biology

Objective:

1. The objective of this course is to familiarize the students with laboratory techniques related to identification and quantification of various biomolecules required to meet the metabolic needs of body.
2. To develop basic practical biochemical skills for the handling and analysis of biomolecules.

Course Assessment:

Mid Term Test	20
End Term Test	20
Teacher Assessment (Based on day to day work, performance in experiments, lab notebook etc.)	60
Total	100

Course Outcomes:

CO I: At the end of the course, the students will be able to identify and analyze various bio-molecules having application in the field of biotechnology.

CO II: Students will be able to design protocols for biochemical assays for carbohydrates, amino acids, proteins, lipids, nucleic acids etc. and interpret biochemical observations in the laboratory.

Index

9.	To estimate the amount of cholesterol present in the serum sample by ZAK's method.
10.	To quantify the concentration of nucleic acid through spectrophotometer.
11.	To determine uric concentration in a given serum sample.
12.	To determine blood sugar concentration in a serum sample.

Reference books and related material:

5. Lab manual
6. An Introduction to Practical Biochemistry - David T Plummer
7. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker
8. Practical Biochemistry-Geetha Damodaran K
9. E-portal of V-labs by Amrita University (vlab.amrita.edu)

10B11BT313 MICROBIOLOGY (Core Course)

Credits: 4

Lecture 3
Tutorials 1

Objectives:

- To provide an understanding of the principles of microbiology and techniques that can serve as a platform for other courses built on microbiological concepts.
- Scientific evaluation of role of microorganisms in various situations like health, industry, agriculture, environment.

Course Assessment:

T1	1 hour	15 (course covered upto T1)
T2	1.5 hour	25 (course covered upto T2, including that covered upto T1)
T3	2 hours	35 (total syllabus)

Tutorials, quiz, and home assignments 25 Total 100

Course Outcomes: On successful completion of the course, students will have the ability to:-

CO I: scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques.
CO II: designate vital role of the microorganisms in the environment and their association with human beings.
COIII: Retrieve and use cotemporary information related to microbial world.

Course Contents and Lecture Plan:

Module No.	Topic	Hours
1	History of microbiology: A timeline with emphasis on Pasteur's experiments disproving spontaneous generation, Koch's postulates	3

2	Forms of microorganisms: Prokaryotes: Archaea & Bacteria, Cyanobacteria (including Mycoplasma & Actinomycetes) Eukaryotes: Fungi, Algae, Protozoa Viruses Morphological features and characteristics, Gram positive and Gram negative bacteria, composition and functions of cellular structures.	6
3	Microbial taxonomy and phylogeny: Taxonomic ranks, classification systems (phonetic, numerical, phylogenetic), major characteristics used for classification (classical and molecular approaches), the three domain system	3
4	Methods in microbiology: Pure culture techniques, theory and practice of sterilization, Principles of microbial nutrition, culture media and types (simple, complex, enriched, enrichment, selective & differential), replica plating techniques, Preservation of Cultures,	5
5	Growth of microorganisms: Media & their types, growth curve of microbes, methods of enumeration, effect of environmental conditions on growth, preservation techniques	4
	Microbial metabolism: Photosynthetic mechanisms, CO_2 fixation mechanisms, fermentation, anaerobic respiration.	4
7	Extremophiles: Thermo & hyperthermophiles, alkaliphiles, acidophiles, halophiles, psychrophiles, radiophiles	3
8	Pathogenic microbes and Control Measures: (Bacteria, fungi, protozoa and viruses), host-pathogen interactions - defense mechanisms against microbes, control of microbes, antimicrobial agents (physical, chemical and biological), Bioterrorism	6
9	Microbial genetics – Conjugation, Transformation, Transduction, Genetic system of yeast and Neurospora.	5
10	Industrial applications with case studies: Biofertilizers, Biopesticides, Biofilms, Biosensors, Fermented foods and beverages, Medicines, Single cell protein.	4
	Total	43

Text & reference books:

1. Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall 2003
2. Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
3. Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
4. Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.
5. Nester : Microbiology Study Guide McGraw Hill.
6. Black : Microbiology : Principles and Applications Prentice Hall

10B17BT373 MICROBIOLOGY LAB (*Core Course*)
Credits 2
Lectures 0 Tutorials 0 Practical 1

Pre-requisites: None

Objective:

The objectives of the lab are to:

- acquaint the students with basic microbiology lab practices
- provide hands-on experience and expertise of culturing, handling and maintaining microbial cultures

Course Assessment:

Mid Semester Evaluation Test	20
End Term Test	20
Teacher Assessment (Based on day-to-day work, practical file, etc)	60
Total	100

Course Outcomes:

CO I: After successful completion of this Laboratory course the students will be able to cultivate, work with and preserve microbial cultures independently.

CO II: They will be able to link bacteria and their other life forms with mutual significance

Topics Covered:

1. Microscopy and Instrumentation: To study construction and working of compound microscope and overview of laboratory instruments (Operation of autoclave, hot air oven, culture room fumigation using formalin). – 2 Labs.
2. Staining- Simple and differential staining of bacteria – Gram Staining, Endospore staining, acid fast staining, fungal staining – 2 Labs.
3. Culture Media Preparation: Preparation and sterilization of bacterial and fungal culture media (Nutrient broth, nutrient agar slant, potato dextrose agar). – 1 Lab.
4. Aseptic Culture Techniques: Streaking and plating methods for isolation of axenic culture of bacteria. Isolation and enumeration of bacteria from soil, water and air using serial dilution technique. – 3 Labs.
5. Bacterial Growth: Study of bacterial growth kinetics using Turbidometry, cell count using haemocytometer. – 1 Lab. (students need to come at least twice a day for 4-5 days to take O.D. of their culture)
6. Antibiotic susceptibility: Study of bacteria using disc-diffusion method. – 1 Lab.

Note: Intermittently, students will be given 1-2 labs. to desing their own experiment on basis of their learning in Microbiology.

Reference Books

1. Benson, Harold J : Microbiological Applications : Laboratory Manual in General Microbiology, McGraw-Hill Higher Education, 2007
2. Cappuccino, James G., : Microbiology: A Laboratory Manual, Pearson EducatioN

Course title : Cell Culture Techniques
Course code: 10B11BT412
Course Credits : 4 (3 Lectures + 1 Tutorial)

Prerequisites: Basic understanding of cell biology (taught in Ist year) along with familiarity with basic culture work (done in Microbiology practicals in last semester)

Objectives

The objective of this course is to introduce the student to basic animal and plant tissue culture techniques and their application. In animal tissue culture component, the course is designed to impart an understanding pertaining to why one needs animal cell cultivation, the basic ATC set-up, the biology of cultured cells, techniques to establish and propagate cell cultures of animal origin. Research based and translational application of ATC will be covered to develop appreciation for learning the distinct cell culture technology subject. In plant tissue culture emphasis would be laid on initiating, establishing and maintaining cell and tissue cultures of several plant species, as well as learning different techniques of plant tissue culture for crop improvement and commercial applications.

Course Assessment:

Test 1	**15**
Test 2	**25**
Test 3	**35**
Teacher Assessment (Assignment + MCQ +Attendance)	**12(4+4+4)** **9(3+3+3)** **4**
Total	**100**

Learning Outcomes :
At the end of the course the student will have the background of animal and plant tissue culture essential for understanding their applications in other fields and planning projects in the field of biotechnology encompassing cell culture based system. Students should be able to design and execute cell culture based experiments in a research setting as well as industrial setting with a thorough clarity in the basic principles.

Module : Animal Cell Culture technology

Introduction to animal cell cultivation: Basics terms and definitions, historical background, Importance of animal cell culture technology, laboratory facilities-design, equipments and safety parameters, waste disposal in a cell culture set-up. Aseptic	2

techniques for animal cell cultivation.	
Cell culture technology: Basic requirement for growing animal cells - Cell culture reagents, media, media supplements, media preparation and sterilization, Defined-Undefined media, Complete-Incomplete media, Importance of Serum and Serum free Media, culture conditions. Maintenance of cell culture: Culturing, sub-culturing, passaging, cell metabolism during culture, **Cell culture types**: primary and continuous culture, *in vitro* transformation of animal cells, anchorage-dependence, monolayer and suspension culture, normal cells and transformed cells. Scaling up- techniques for cells in suspension and in monolayer **Cell line preservation and authentication:** cryopreservation and cell revival, Cell line banking and cell culture databases. Contamination check and prevention: bacterial, yeast, fungal, mycoplasma, viral testing.	2 2 2
Studying biological system using cell culture techniques: Functional assays based on cell culture: Cell morphology, Quantitation, Growth pattern, DNA content and cell cycle, Cytotoxicity assays, Study of Cell Death: senescence, apoptosis and necrosis, Cell proliferation, Cell viability measurements, Karyotype analysis, FISH. **Immunolabeling of cells** to study molecular expression pattern–Microscopy, Flowcytometry, Cytospin, Immunohistochemistry, Transfection, Transient and stable cell line generation.	4 4
Cell and Tissue culture- Trends and Breakthroughs: **The first products of animal cell technology:** hybridoma technology for monoclonal antibody production, production of genetically-engineered cells and their applications, use of cell cultures in the production of biologicals, Insect Cell Culture and its application **ES cells and Adult stem cells:** differences between stem cells and differentiated cells, embryonic stem cells and adult stem cells for therapy **Tissue engineering, Three-dimensional culture:** multicellular tumour spheroids MCTS)-mono and co-cultures, re-aggregate organ cultures, drug testing *in-vitro.*	2 2 2
Total	**21**

Module Plant cell culture	**21**
Plant structure, growth and development	**2**
Introduction, definitions and history of plant cell and tissue culture	2
Organization of tissue culture laboratory	1
Cellular totipotency and cell differentiation, factors affecting differentiation	2
Isolation of single plant cells, suspension cultures, types of suspension cultures, Measurement of the growth in suspension cultures, Assessment of Viability of the cultured cells, bioreactors used for plant cell cultures	2
Type of cultures and their applications: Direct and indirect methods of culture; seed culture, embryo culture, organ culture, callus culture, somaclonal variation and	2

applications	
Somatic embryogenesis	1
Micro-propagation and its applications, Advances in acclimatization of tissue cultured plants.	2
Haploid and triploid production and applications	2
Protoplast isolation and fusion and application	2
Production of virus free plants through cell and tissue culture	1
Secondary metabolite production and bioconversions /biotransformation through plant cell cultures and plant stem cells	2

Text books :

1. Michael Butler, "*Animal Cell Culture and Technology*", BIOS Scientific Publishers
2. John R.W. Masters, " *Animal Cell Culture-A Practical Approach*", Oxford University Press
3. R. Ian Freshney, **"***Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*".
4. Introduction to Plant biotechnology H S Chawala
5. Plant tissue culture: theory and Practice S.S.Bhojwani and M K Razadan
6. Plant tissue culture S.S.Bhojwani and M K Razadan

Plant Tissue Culture Lab

Practicals 2

Course Objective:

To develop understanding among students about the translation of the theoretical aspects of plant cell culture into a practical format by designing small projects and technical ways of handling.

Course Assessment:

Midterm Evaluation	20
Final Evaluation	20
Regular Lab Work	30
Total Attendance and Discipline	15
Lab Record	15
Total	100

Course Outcomes:

CO 1: To enable students for applying the knowledge about basic techniques of plant tissue culture

CO 2: Able to apply the learnt techniques for solving problems linked with plant propagation and

technologies for phytochemical productions

CO 3: Able to learn the strategies for analyzing, upscaling and commercialization of plant based products

CO 4: The students will have the hands on different techniques of plant tissue

CO 5: Able to formulate the methodologies for maintaining and developing organ and cell cultures of plants

CO 6: To be able for developing skills for benefit generation and utilization of techniques of PTC

CO7:The students can be equipped to handle the projects on optimization of culture conditions for phytochemical productions

Topics Covered:	**Lab Hours**
1.Introduction to various equipments and their working in plant tissue culture lab setup	2
2.Preparation of stocks solutions, hormones culture medium	2
3.Preparation of different types of explants for culture	2
4.Initiation and establishment of callus cultures	2
5Establishment of Suspension cultures and measuring cell growth	2
6.Plant regeneration by organogenesis from callus and suspension cultures	2
7.Microproapagation of different plant species	4
8.Mass propagation of important plants through bioreactor	4
9.Development of low cost micropropagtaion technology for an endangered medicinal herb(*Picrorhiza kurroa*)	3
10.Acclimatization of cultured plantlets to field conditions	2
11.Meristem culture for virus elimination	3
12.Anther and pollen culture for haploid production	2
13.In vitro cell line selection	2

14.Protoplast isolation, somatic hybridization and determining the protoplast viability	4
15.Production of industrial metabolites through cell culture technologies	4

Projects of Plant tissue culture lab:

- To prepare a concept note for utilizing any of the plant tissue culture technology for the propagation , conservation and improvement of any important plant sp. of their native area

- Submit any of your conceived idea and work plan for the production of any important plant product.

. Any model system working or non working where applications can be tested

Activities: hands on experience about all practicals are given along with documentation of records on all experiments and observations are mentioned in students respective lab notebooks.

Text/Reference Books

1.Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application (Principles and Practice) by: Karl-Hermann Neumann publisher: Springer

2.Tissue Culture for Plant Propagators by R.A. de Fossard

3.Plant Culture Media, Volume 1,Formulations and Uses

by E.F. George,

4.Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers

Animal Tissue Culture Lab

Course code: 10B17BT472

Course Objectives:

COI Background of animal tissue culture, Maintain aseptic condition, preparation of media, transfer of fluids in a aseptic condition, waste disposal and safety parameters, etc.

COII Execute primary and continuous culture of cell lines, handle suspension and adherent cells, cryopreservation and revival of cell lines.

COIII Perform functional assay at cellular level, cell morphology and survival, immunolabeling,.

Course Assessment:

Midterm Evaluation	20
Final Evaluation	20
Regular Lab Work	30
Total Attendance and Discipline	15
Lab Record	15

Total	100

Topic
1. Introduction to ATC 2. Fluid Transfer using aseptic technique 3. Media Preparation
4. Preparation of stock media from powder and filter sterilization 5. Sub culturing of suspension culture 6. Sub culturing of adherent culture 7. Cryopreservation 8. Revival of culture
9. Estimation of cell number 10. Observation cultured cells 11. Assessment of cytotoxicity using MTT assay 12. Fluorescent labeling of DNA and protein
13. Isolation of lymphocytes from blood 14. Establishment of primary cell culture 15. Biological screening of herbal/synthetic molecules

Total

Text books for Animal cell culture module:

7. Michael Butler, "*Animal Cell Culture and Technology*", BIOS Scientific Publishers
8. John R.W. Masters, " *Animal Cell Culture-A Practical Approach*", Oxford University Press
9. R. Ian Freshney, "*Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*".

Molecular Biology

Course code: 10B11BT413 Core Course

Credits: 4, L3 T1 P0

Pre-requisites: Fundamental Biology, Biochemistry Cell biology

Course Objectives (Learning Goal):

1. This course covers the basic principles of molecular biology and its practical applications.
2. The main objective of the course is to equip students with a detailed knowledge of molecular biology in the context of human diseases
3. To prepare students for future research and also enhance their career prospects in the expanding life sciences sector including public-funded research laboratories or private industry.

Course Outcomes:

CO I: Able to understand foundational scientific principles and findings in current molecular biology.

CO II: Understand how molecular machines within the cell are constructed and regulated so that they can accurately copy, repair, and interpret genomic information.

CO III: Discuss and analyze original scientific research articles on molecular biology topics

Exam	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-2
T2 Test	25	1.5 hrs.	Unit 1-4
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Whole Semester(Quiz, short presentations)	Inform class time to time
Total	100		

Module No.	Unit	Topics in the module	Hours
1.	Basics of Molecular Biology	a) Why Molecular Biology? b) How molecular biology came about? c) Major events in molecular biology d) Nucleic acids; DNA and RNA and their structure and function in detail e) Protein structure, basic functions, DNA-Protein interactions, molecular details of protein purification f) DNA structures and their implication in diseases	4
2.	Molecular Biology Techniques and their Applications	a) Polymerase chain reaction b) DNA sequencing; c) Western blot d) Southern and northern blotting e) DNA foot-printing f) Immuno-fluorescence	8
3.	DNA replication	a) Avery Mcleod and Mccarty experiments b) Hershey Chase Experiment c) Maintenance of DNA sequence d) Linking number of DNA e) Forces which stabilize the DNA secondary structure f) DNA polymerase g) Replication process: Initiation, Extension,	8

		leading strand, lagging strand, Dynamics at the replication fork, termination h) DNA replication protein i) DNA replication regulation: Eukaryotes and prokaryotes	
4.	DNA transcription and RNA processing	a) History b) RNA polymerases c) Major steps in transcription: Pre-initiation, Initiation, Promoter, elongation, Termination d) mRNA splicing mechanisms e) rRNA modifications f) Reverse transcription g) Transcription inhibitor h) Post-transcription modification	8
5.	Translation	a) Basic mechanism-Eukaryotic and Prokaryotic translations b) composition of Ribosomes c) Genetic codes d) Role of tRNA in translation e) mRNA translation mechanisms: initiation, elongation and termination process	8

6.	Gene regulation and Post-translational modification	a) Why cells need to regulate genes b) control of gene regulation c) Operon (Trp Operon,Lac operon) d) Regulatory proteins; Helix turn-helix, Leucine Zipper, Zinc finger e) Post translational modifications f) Effects of post-translational modifications g) Why protein post-translational modification are made h) Types of post-translational modifications i) Methods used to study post-translational modifications	6

Text books:

1. Stryer, Lubert (2002). Biochemistry; Fifth edition. W. H. Freeman and Company.
2. Lehninger "Principles of Biochemistry".
3. R. K. Gaur, Yedidya Gafni, P. Sharma, V. K. Gupta. "RNAi Technology". CRC Press

Reference books:

1. Lodish H, Berk A, Zipursky LS, Matsudaira P, Baltimore D, Darnell J (2000). *Molecular Cell Biology*. W. H. Freeman and Company
2. Lewin's GENES XI
3. Molecular Cell Biology Damell Jr. J., Lodish, H and Baltimore, D. Scientific American Inc., New York
4. Neill, Campbell (1996). Biology; Fourth edition. The Benjamin/Cummings Publishing Company. p. 309,310. ISBN 0-8053-1940-9.

Molecular Biology Lab

(Core Course10B11BT473)

Credits 02

Pre-requisites: Cell Biology, Biochemistry

Objectives:

3. The objective of this course is to familiarize the students with laboratory techniques related to isolation and quantification of various biomolecules required to meet the metabolic needs of body.
4. To develop basic practical skills for the handling and analysis of biomolecules.

Course Assessment:

Mid Term Test	20
End Term Test	20
Teacher Assessment (Based on day to day work, performance in experiments, lab notebook etc.)	60
Total	100

Course Outcome: At the end of the course, the students will …..

CO I: be able to understand, and perform, molecular biology techniques accurately and safely.

CO II: be able to isolate, quantify and visualize various biomolecules having application in the field of biotechnology.

CO III: be able to report experimental results in a standard written format and to write coherently and persuasively about conclusions from such results and their significance.

Experiment	TITLE
	Good Lab Practice and Calculations of molarity and normality of the solutions
1.	To isolate genomic DNA from *E. coli* (DH5-α) using heat boiling method.
2.	Quantification of DNA concentration and purity by nanodrop method.
3.	To perform agarose gel electrophoresis.
4.	To isolate *E. coli* (DH5-α) genomic DNA using phenol chloroform method.
5.	Isolation of genomic DNA from human blood sample.
6.	To isolate plant genomic DNA using CTAB method.
7.	To isolate *E. coli* (DH5-α) plasmid DNA by alkaline lysis method.
8.	To isolate RNA from bacterial cell.
9.	Introduction to Polymerase Chain Reaction and to amplify gene using genomic DNA of *E. coli*.
10.	To perform restriction digestion using *E. coli* plasmid DNA.
11.	To separate serum and plasma proteins from human blood.

12.	To visualize human serum and plasma proteins using SDS-PAGE technique.

Suggested Ref. books:

1. Lab manual
2. Michael R. Green and Joseph Sambrook. Molecular Cloning, A Laboratory Manual. fourth edition.
3. Keith Wilson and John Walker (2010).Principles and Techniques of Biochemistry and Molecular Biology, seventh edition.

Environmental Studies (10B11GE411)

Course code: 10B11GE411 Course Credits: (3 - 0 - 0)

Aim: To impart awareness about current environmental issues and to create a learning environment for achieving a sustainable development.

Objectives: Recognizing the major concepts of environmental studies, developing problem solving ability, forecasting the global climate change

Learning Outcome: Enhanced scientific learning and competence for environmental issues.

Modules	Description	No. of lectures
For T1		
1	The Multidisciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness, Types of Ecosystems, World Biomes, Ecosystem functioning, Biogeochemical cycles.	3
2	Natural resources, their consumption & Protection: Water, Land Energy (Renewable, non-renewable, wind, solar, hydro, Biomass), Mineral, Forest, & Food resources, Role of an individual in conservation of natural resources, Equitable use of resources.	5
3	Pollution- a threat to environment: Air, Water & Land pollution, sources & causes, Space pollution, causes & effects, toxicity limits of pollutants. Critical issues concerning global Environment (Urbanization, population growth, global warming, climate change, acid rain, ozone depletion etc.) and the Roots in: Cultural, Social, Political, Commercial, industrial, territorial domains.	5
For T2		
4	Biodiversity loss: Diversity of flora and fauna, species and wild life diversity, Biodiversity hotspots, threats to biodiversity	3
5	Environmental Impact assessment: Objectives of impact assessment, Study of impact parameters, Methods for impact identification, Economics.	3
6	Environmental standards & Quality: Air, Water & Soil Quality, Pollutant sampling, pollution control systems. Green Chemistry and its applications.	4
7	Sustainable building, Urban planning, Disaster Management and Contingency Planning, Modern safety systems.	3
For T3		

8	Waste land reclamation, consumerism and waste products, eco-consumerism, dematerialization, green technologies, eco-tourism. water conservation, rain water harvesting, watershed management	4
9	Environment protection act, Air (prevention and control of population) act; Water (prevention and control of pollution) act, Wildlife protection act, Forest conservation act, Issues involved in enforcement of environmental legislation National Environmental Policy; Function of pollution control boards (SPCB and CPCB), their roles and responsibilities, Eco-mark Scheme, Laws relating to Urbana and Rural land use, Ethics	4
10	Fire Crackers and Environment: Impact and Safety	1
11	Case studies: Industry – Environment interface	2
12	Field Work: Explore the surrounding flora & fauna (Study of common plants, insects, birds document environmental assets), documentation of industries in local region and their possible effects, measure of water, air and land quality, Visit to a local polluted site-Urban/Rural /Industrial / Agricultural, Study of simple ecosystems-pond, river, hill slopes etc	5
	Total	42

Evaluation Scheme:

T1 Test	15
T2 Test	25
T3 Test	35
Teacher Assessment Problem solving sessions and quiz – Total three in no. (marks 12) Regular Assignments (marks 09) Attendance (marks 04)	25
Total	100

Teaching and Learning Strategies

This includes: - Structured overview of the course and lecturing, debates, discussions and problem solving sessions, case studies, query sheets and writing.

Text books:

1. Joseph, B., 2005, Environmental Studies, Tata McGraw Hill, India.
2. Textbook of Environmental Studies for UG Courses - Erach Bharucha, University Press

Reference Books

1. Nebel, B.J. & Wright, R.T., 1993, Environmental Science, 8th Edition, Prentice

Hall, USA

Chiras D D.(Ed.). 2001. Environmental Science – Creating a sustainable future. 6th ed. Jones & Barlett Publishers.

1. David Laurance. 2003. Environment Impact assessment, Wiley publications.
2. Chhokar KB, Pandya M & Raghunathan M. 2004. Understanding Environment. Sage publications, NewDelhi

Other suggested material:

1. Issues of the journal: Down to Earth, published by Centre for Science and Environment
2. Audio visuals from: Discovery, National Geographic etc.
3. Rachel Carson 1960. Silent springs

10B11BT514 IMMUNOLOGY (*Core Course*)
Credits 4
Lectures 3 Tutorials 1 Practical 0

Pre-requisites: Basic Biology

Objective:

The objective is to understand gain in-depth knowledge of basic immunology and roles played by immune system in various common diseases.

Course Assessment:

Mid Term Test	30
End Term Test	45
Teacher Assessment (Based on Assignments, quizzes, presentation etc.)	25
Total	100

Course Outcomes:

CO I: Understand and apply basic concepts of immunology.

COII: Understanding the mechanisms of regulation of immune responses and immunological tolerance, role of immune cells, major histocompatibility complex, antigen-antibody interactions in diagnostics.

COIII: Understand the roles played by immune response in: infectious diseases, autoimmunity, hypersensitivity reactions, immunodeficiency diseases and vaccines.

Topics Covered:

Basics of Immunology: innate and acquired immunity; T-cells and B-cells; antigens; immunoglobulins structure and function; organization and expression of immunoglobulin genes; antigen-antibody reactions; major histocompatibility complex (MHC) structure, inheritance and role in susceptibility to diseases.

Immune response/ tolerance regulation mechanisms: cytosolic and endocytic pathway; responses in humoral and cell mediated branch; immunological tolerance; complement system; cytokines; autoimmune diseases; types/mechanisms of hypersensitivity reactions; types of vaccines, active and passive immunization; immune response to viral, bacterial, protozoan and parasitic infections; tumor immunity and immunodeficiency diseases.

Text/Reference books

1. Kindt TJ, Goldsby RA and Osborne BA (2007) Kuby Immunology .W.H. Freeman and Co., New York, 6th Ed.
2. Abbas AK, Lichtman AH an Pillai S (2011) Cellular and Molecular Immunology. Elsevier USA, 7th Ed.
3. Coico R and Sunshine G (2009) Immunology: A Short Course. Wiley – Liss, 6th Ed.

4. Delves PJ, Martin SJ, Burton DR and Roitt IM (2011) Roitt's Essential Immunology. Wiley-Blackwell, 12th Ed.

10B17BT574 IMMUNOLOGY PRACTICALS (*Core Course*)

Credits 1
L 0 T 0 P 2

Pre-requisites: Basic Biology, Immunology

Objective:

The objective is to familiarize students with the various immunological techniques that include antigen-antibody interactions, quantitation of antigens or antibody, ELISA, agglutination reactions etc.

Course Assessment:

Mid Term Viva and Exam	20
End Term Viva and Exam	20
Day to Day assessment	60
Total	100

Course Outcomes:

COI: After this course students would have hands on training for various immunological techniques.

COII: Able to design, analyze and interpret experiments related to immunology.

COIII: Able to apply practical knowledge to understand various immunological changes occurring during diseases.

Topics Covered:

1. To quantitate unknown amount of antigen applying Radial Immunodiffusion (RID) by Mancini's technique.

2. To quantitate unknown amount of antigen applying Double Immunodiffusion (DID) by using Ouchterlony method.
3. Determination of antibody concentration using Quantitative precipitation assay-test.
4. To perform hemagglutination assay for ABO blood group typing determination of and Rh factor.
5. To quantitate antigen concentration applying technique of rocket Immuno-electrophoresis.
6. To perform Immuno-electrophoresis of given sample.
7. To determine the concentration of antigen by sandwich ELISA method.
8. To determine Total Leukocytes Count (TLC) of the given sample.
9. To determine Differential Leukocytes Count (DLC) of the given sample.
10. Isolation of lymphocytes from peripheral blood by ficoll method and check the viability of isolated lymphocytes.
11. Amplification of Interleukin-28b gene using Polymerase Chain Reaction assay.
12. Lysis of red blood cells (hypotonic lysis with H_2O and ammonium chloride)
13. To perform Erythrocyte Rosette-forming Cell Test, ERFC.

Reference books

1. Lab Manual
2. Hay FC and Westwood OMR (2003) Practical Immunology, 4^{th} Ed., Blackwell Publishing

Course Title: Genetic Engineering

Course Code: 10B11BT513

Course Credits: 4

Course Coordinator Dr. Anil Kant

Objectives: The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Learning Outcome:

CO I: The students will have knowledge of tools and strategies used in genetic engineering.

CO II: Understanding of applications of recombinant DNA technology and genetic engineering from academic and industrial perspective

CO III Can use and apply the knowledge of genetic engineering in problem solving and in practice

	Topics	Hours Allotted
1	Genetic engineering, Recombinant DNA technology: gene cloning - concept and basic steps - rDNA Glossary	2
2	DNA modifying enzymes and DNA modifying enzymes and cloning techniques Restriction Endonucleases, DNA Ligation Enzymes and, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, and Reverse transcriptases other tools used for DNA Modification	5
3	Cloning Vectors and Expression Vectors: Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules, yeast cloning vectors, Expression Vectors, Transcriptional & Translational Fusions, Adding Tags and Signals overproducing Proteins	6
4	Construction & Screening of genomic libraries: Genomic library, cDNA library, Growing & Storing Libraries, Screening Libraries with Gene Probes, Screening Expression Libraries with Antibodies	4
5	Gene Cloning Strategies: Positional Gene Cloning, cDNA Cloning (5'&3' RACE) ,Heterologous Gene Cloning, Subcloning, Characterization of Cloned Genes	5

6	Sequencing And Mutagenesis: Basic DNA Sequencing, Whole genome sequencing, Next generation sequencing technologies, Site-Directed Mutagenesis	4
7	Gene Expression in Microbial and Eukaryotic Systems: Cloning in *E. coli*, in Gram-positive bacteria, in Streptomycetes, in *Saccharomyces Cerevisiae* and Other Fungi, in Insect Cells, in Mammalian Cells	5
8	Genetic Manipulation Of Plants and Animals: Gene transfer, Application of Genetically Engineered Strains of Plants and Animals	4
9	Advances in transgenic technology	4
10	Biosafety Issues related to recombinant DNA Technology	2
	Total	41

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments will also be given.

Evaluation Scheme:

Exam	% of Marks	Duration of Examination
Test1	15	1Hours
Test2Mid Tem	25	1.5Hours
Test3End Term	35	2 Hours
Internal Assessment	25	Entire Semester

Text Books:

1. Principles of Gene Manipulation by S.B. Primrose, RM Twyman and RW Old (6^{th}Edition)
2. Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman
3. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.
4. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz

5. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ

Course Title: Genetic Engineering Lab.

Course Code: 10B17BT573

Course Credits: 0 0 4

Course Coordinator Dr. Anil Kant

Objectives:

The objective of the course is to give practical exposure to student about basic tools and techniques employed in recombinant DNA technology and genetic engineering.

Learning Outcome:

CO I: The students will have hands on experience on tools and strategies used in genetic engineering.

CO II: Can design and carry out experiment related to Recombinant DNA technology and Genetic Engineering

	Topics	Hours Allotted
1	Introduction to rDNA laboratory, w.r.t. working bench, types of instruments and their handling, lab. Preparation of stock solutions of buffers for use in gel running, gel loading, their autoclaving; preparation of working buffers, antibiotic stocks, and storage of buffers required in rDNA practicals with detailed methodology	4
2	Plasmid DNA Preparation: Preparation of LB medium with and without antibiotics for the growth of bacterial cultures, Growth of *E. coli*, Isolation of Plasmid DNA, Electrtrophoresis of Plasmid DNA and Interpretation of results	8
3	Restriction of given plasmid or λ DNA with the restriction enzyme *Eco*RI and HindIII or any other Restriction Enzymes, Electrophoresis of the uncut and digested DNA and Interpretation of the results	4
4	To perform ligation of λ/*Eco*R I digest using T4 DNA Ligase and analyze the ligated samples by agarose gel electrophoresis	4
5	Setting up a PCR reaction to amplify a gene or a DNA fragment using gene	4

	specific primers	
6	Preparation of competent cells of *E. coli* transformation	8
7	To insert the PCR product into T vector by TA-cloning, and confirmation	8
8	Transformation of E.coli. DH5 α cells with Empty puc/ pcambia1301/and Confirmation of transformed cells by scoring the expression of LacZ gene.	8
9	Transformation of E.coli. DH5 α cells with Recombinant T- vector/puc vector Confirmation of transformed cells by scoring the expression of LacZ gene.	8
10	RNA isolation and to synthesize cDNA from total RNA preparation using reverse transcriptase and oligodT primer	10
	Total	66

Course Title	Bioprocess Engineering	(Core Course)
Course Code		
Course Credit	4	

L	T	P
3	1	0

Course Coordinator Dr. Saurabh Bansal

Pre-requisite Thermodynamics and Chemical Processes, Microbiology

Course Objectives

The objective of the course is to develop an understanding of important concepts and design aspects of bioreactors and their functioning and scale up.

Course Assessment

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-2
T2 Test	25	1.5 hrs.	Unit 1-5
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Whole Sem	Inform class time to time
Total	100		

Course Outcomes

CO I	Able to use correct biological terms to describe & analyze phenomena/ problems in bioprocesses
CO II	Able to apply engineering principles to address issues in various bioprocesses
CO III	Able to analyze bacterial growth kinetics (homogeneous reaction) in batch /continuous/ Fed-batch reactor and sterilization
CO IV	Able to understand and to solve problems related to bioprocess phenomena

	including mixing, Mass transfer and sterilization
CO V	To develop a strong foundation about bioreactor designs and their applications
CO VI	Able to understand the basis of bioprocess scale up and the related basic design calculations

Topic Covered

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction	Role of bioprocess engineer, Microbial process development, Quality control management, Fermentation Economics	4
2	Kinetics of Microbial growth	Batch culture, Kinetic implications of endogenous and maintenance metabolism. Continuous culture, Modifying continuous reactors: Chemostat with recycle and multistage Chemostat Systems. Modifying batch reactors: Fed-batch operation, Perfusion systems.	7
3	Sterilization	Design of batch and continuous sterilization processes, kinetics of thermal death of cells and spores.	2
4	Mixing	Mixing equipments, flow patterns in reactors, mixing mechanism, power consumption and shear properties of sparged and agitated vessels and various mixing agitators.	4
5	Mass Transfer	Role of diffusion in bioprocessing, film theory, convective mass transfer, oxygen uptake in cell cultures. Oxygen transfer in fermenters: measuring dissolved-oxygen concentration, estimating oxygen solubility, mass transfer correlation, measurement of k_La, oxygen transfer in large vessels.	7
6	Strain Improvement and Media Formulation	Strain improvement of industrially important microorganisms, Media formulation industrial fermentations.	5
7	Immobilized Cell Systems (ICS)	Immobilization and its limitations, Active and passive immobilization, applications of immobilized cell biocatalysts. Diffusional	3

		limitations in ICS. Bioreactor considerations.	
8	Bioreactor design and analysis	Bioreactor configurations and its utilities, Analysis of ideal and non-ideal reactors. Multiphase reactors: packed-bed reactors, bubble-column bioreactors, fluidized bed bioreactors, trickle-bed reactors. Practical considerations for bioreactor construction, Bioreactors instrumentation and control. Bioprocess Considerations: Animal cell cultures & plant cell cultures	5
9	Scale up and Scale down	Scale up of bioprocesses and its difficulties. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed. Scale down.	5
	Total Number of Lectures		42

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and numerical problems will also be given.

TEXT BOOKS

1	Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
2	M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3	Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).

REFERENCE BOOKS

1	Klaas Van’t Riet, Johannes Tramper, “Basic Bioreactor Design”, 2nd ed., Marcel Dekker, Inc., New York, 1991.
2	Bailey and Ollis, “Biochemical Engineering Fundamentals”, 2nd ed., McGraw-Hill Book Company, New York, 1986.

3	Mccabe L.Warren, Smith C. Julian and Peter Harriott, “Unit Operations of Chemical Engineering”, 6th ed., McGraw Hill International Edition, New York, 2001.
4	Abhilasha S. Mathuriya, “Industrial Biochnology” 1st ed., Ane Books Pvt. Ltd., New Delhi, 2009.

Course Title	Bioprocess Engineering Lab	(Core Course)
Course Code		
Course Credit	01	
Course Coordinator	Dr. Saurabh Bansal	
Pre-requisite	Microbiology Lab	

L	T	P
0	0	2

Course Objectives

The objective of the course is to

- Provide exposure to the students with hands on experience on various practices in Bioprocess Engineering.
- Enable students to link the theoretical knowledge of process engineering with the experiments.

Course Assessment

Assessment	Max. marks
Mid Term Viva	20
Teacher Assessment (Based on day to day work, performance in experiments, lab notebook etc.)	60
End Term Viva	20
Total	100

Course Outcomes

CO I	Able to apply practical knowledge to understand the various important process engineering aspects involved in biotechnology industries
CO II	Able to design experiments and analyze various data related to various practices in bioprocess engineering
CO III	Ability to apply theoretical concepts for data analysis and interpretation and their documentation

CO IV	Able to run fermenter and also to analyze their results
CO V	Able to understand and determine various growth kinetics parameters in a batch culture
CO VI	Able to work in a team to accomplish the experiments and to document the experiments properly in lab note books

List of Experiments

S. No.	Unit	Title of Experiments
1	Introduction	Introduction of Lab and lab safety
2	Bioreactor Design	Describe the various parts of the bench-top fermenter (bioreactor) along with their functions.
3	Sterilization	To determine the thermal death point of a microbial culture.
4		To determine the thermal death time of a microbial culture.
5	Growth Kinetics and Analysis	To estimate the reducing sugar concentration in a given sample using DNS method.
6		To estimate the sugar concentration in fresh and spent media using DNS method.
7		To establish the correlation between OD and dry cell weight.
8		To study the different phase of microbial growth.
9		To study growth kinetics parameters of *E. coli*. a) Specific growth rate (μ) h^{-1} b) Maximum specific growth rate (μ_m) h^{-1} c) Saturation constant (K_s) gm/l d) Growth yield coefficient ($Y_{x/s}$) gm cell/gm substrate. e) Productivity of biomass gm cell/litre/h.
10		To study the effect of varying carbon substrate on specific growth rate
11	Mass Transfer	Determination of Volumetric mass transfer coefficient (K_La) using dynamic gassing out method (Virtual Lab)
12	Immobilized Cells and Mass transfer Limitation	Preparation of Immobilized yeast cells in calcium alginate beads
13		Compare the conversion of sugar rate by incubating sugar solution with cell suspension and immobilized cells

Methodology

The course will be covered through lectures, demonstration and hands on experiments.

TEXT BOOKS

1	M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
2	Lab Manual

REFERENCE BOOKS

1	Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
2	Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).

Course Title	Introduction to bioinformatics	(Core Course)
Course Code	10B11BT511	
Course Credit	4	

L	T	P
3	1	0

Course Coordinator Dr. Jayashree Ramana

Pre-requisite Molecular Biology

Course Objectives

The objective of the course is to develop an understanding of important concepts of bioinformatics with a focus on next generation sequencing and its applications in the contemporary world.

Course Assessment

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-2
T2 Test	25	1.5 hrs.	Unit 1-5
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Whole Sem	Inform class time to time
Total	100		

Course Outcomes

CO I	Knowledge of bioinformatics databases and resources
CO II	Sequence analysis including pairwise sequence alignment
CO III	Sequence analysis using multiple sequence alignment
CO IV	Sequence annotation by identifying motifs, domains, conserved regions, predicting secondary structure of protein sequences
CO V	Perform phylogenetic analysis of protein sequences and RNA secondary structure prediction

Topic Covered

Sl. No.	Unit	Topics covered	Contact hours
1.	Introduction	Bioinformatics and its role in modern biology, Current scenario of Bioinformatics in India	2
2.	Databases	Biological databases: classification into different types; sequence retrieval and sequence submission PubMED Nucleic acid sequence database (NCBI, EMBL, DDBJ) Genome database (TIGR) Protein sequence database (SWISSPROT) Databases of metabolic pathways	3

		(KEGG) ENTREZ, sequence retrieval system (SRS), Protein identification resource (PIR), Expert Protein Analysis System (ExPASY), Ensembl, sequence formats, Seqin, BankIt	
3.	Sequence Alignment	Sequence Alignment: Dot plots, Alignments (Needleman & Wunsch algorithm, Smith-Waterman algorithm-with simple scoring systems), Multiple sequence alignment, Amino acid distance measures (PAM matrices, Blosum matrices)	5
4.	Database search	Database searching : FASTA, BLAST	3
5.	Fundamental of sequence alignment	Sequence similarity: Basic concepts, similarity scores	2
6.	Primer design	Principles, Programs for Primer Design	2
7.	Distance measures	Nucleotide distance measures (simple counts method, Jukes-Cantor correction, Kimura 2 parameter correction);	4
8.	Phylogenetic reconstruction	Introduction, distance method (UPGMA, NJ), parsimony method	7
9.	Gene prediction	Principles and programs for Gene prediction.	2
10.	Molecular modelling	Homology modeling, docking, energy field calculations, molecular dynamics	2
11.	Protein sequence analysis	Primary sequence analysis, protein structure visualization and Secondary structure prediction	7
12.	RNA secondary structure prediction	Principles and programs for RNA secondary structure prediction	3

		Total	42

Methodology:

The course will be taught through lectures and labs. Apart from the discussions on the topics covered in the lectures home assignments will also be given.

Text Books:

1. Bioinformatics: D.W. Mount

2. Introduction to Bioinformatics by Arthur Lesk

3. Bioinformatics: Databases, tools and Algorithms by Orpita Bosu and Simminder Kaur Thukral

4. Knowledge discovery in Bioinformatics: Xiaouha Hu, Yi Pan

Course Title	Introduction to Bioinformatics Lab	(Core Course)
Course Code	10B17BT571	
Course Credit	1	L: 0, T: 0, P: 2
Course Coordinator	Dr. Jayashree Ramana	
Pre-requisite	None	

Objective

To get a hands-on of various bioinformatics programs in online and offline mode for sequence annotation and analysis

Course Assessment:

Assessment	Max. marks	Duration	Course Covered
Day to day work based on: i. Attendance and discipline in lab ii. Learning laboratory skills, and comprehensive understanding and application about the experiments iii. Laboratory record	60 (15) (30) (15)		Whole semester
Mid-semester lab Exam– (viva/test)	20		Course covered up to Mid Semester
End Semester lab Exam– viva/test	20		Whole semester
Total	100		

Course Outcome

CO I	advanced searches in NCBI and Expasy resources
CO II	Sequence analysis including alignments and phylogenetic analysis
CO III	Mapping of metabolic enzymes and various proteins to KEGG and GO

Topics Covered (List of Experiments):

S. No.	Lab No.	Topic
1	Lab 1	Retrieval of sequences from NCBI and hands-on of EMBOSS software for various types of sequence analysis
2	Lab 2	Lab 2: BLAST program in online page and standalone package
3	Lab 3	Lab 3: Use of expasy resource for sequence retrieval and analysis
4	Lab 4	Lab 4: Multiple sequence alignment (MSA) programs and viewers: ClustalW, Jalview in online mode
5	Lab 5	Lab 5: Use of MSA programs (ClustalW) as a standalone package
6	Lab 6	Lab 6: Use of structural databases like PDB and structure visualization using Pymol and Rasmol
7	Lab 7	Lab 7: Use of structural classification databases like SCOP, CATH, FSSP
8	Lab 8	Lab 8: Use of gene prediction methods
9	Lab 9	Lab 9: Phylogenetic analysis methods and tree viewers: Phylip and Archaeopteryx
10	Lab 10	Lab 10: Use of Phylip software as standalone package, MrBayes etc.
11	Lab 11	Lab 11: KEGG and GO database

12	Lab 12	Lab12: Homology modeling in MODELLER, Docking in PatchDock
13	Lab 13	Lab 13: Prediction of RNA secondary structure
14	Lab 14	Lab 14: EMBOSS, STADEN and STAMP packages for sequence analyses

Methodology

The course will be taught through short lectures and hands-on practicals. Specifically, the following will be implemented throughout the course.

- Short lectures in class that introduce the concept and problem in hand.
- Followed by short demonstration of what to do and what is expected.
- One on one question to students to ensure they understood the expectations and methods.
- Documentation in the form of lab notebook and online submissions

TEXT BOOKS

1	Pevsner J.:Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, New York.
2	Baxevanis AD & Oulette BFF : Bioinformatics – A practical guide to the Analysis of Genes and Proteins, Willey International publishers.

Comparative and Functional Genomics

Course Code: 10B11BT611 Core Course Credits: 4 L 3 T 1 P 0

Pre-requisites: Molecular Biology, Biochemistry

Course Objectives (Learning Goal):

1. The course is intended to provide thorough understanding of the genomics i.e. modern technologies in whole genome sequencing, genome mining, comparative genomics, global gene function technologies, protein structure & function technologies at the genome level, etc.
2. The course will explore that how technological innovations fostered by the Human Genome Project, will lead to significant advances in our understanding of diseases that have a genetic basis and, more importantly, how health care will be delivered from this point forward

Course Outcomes:

CO I: Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, genome annotation, global gene cloning and gene expression technologies, comparative genomics, introduction to pharmacogenomics, proteomics.
CO II: The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes.
CO III: Able to analyze the gene expression data sets to derive the biologically meaning information
CO IV: Able to apply the knowledge of function genomics in public healt

Topics covered:

Genes and Genomes, Genome Organization, Exon-Introns, Alternate splicing, Model Genomes: Prokaryotes & Eukaryotes. Genetic and Physical Mapping of Genomes. Whole Genome Sequencing Technologies (Next generation sequencing Pyrosequencing & Reverse termination sequencing). Genome Annotation i.e. Mining Genomic Sequence Data, gene prediction methods, Comparative genomics. SNP Technologies: Platforms & Analysis Haplotyping: Concepts and Applications. Pharmacogenomics: Concepts and Applications in Healthcare. Global Gene Cloning & Expression Platforms & Technologies (Differential Display, SAGE, Microarrays, cDNA-AFLP, etc.). Gene Function Technologies (Gene Targeting, Gene Silencing (RNAi)).
Proteomics: Protein-Protein Interactions; Protein Arrays, global analysis of protein modifications. Proteomics: Protein Structure and functions prédiction

(and Analysis). Biomarkers : Identification & Utilization

Topic	Lectures	Learning Outcomes
Module-I: Genes, Genome of Prokaryotes vs Eukaryotes		CO-I
Genes and Genomes, Genome Organization,	1	
Exon-Introns, Alternate splicing	1	
Model Genomes: Prokaryotes & Eukaryotes	1	
Module-II: Genome Mapping & Sequencing Technologies		CO-II
Mapping of Genomes	2	
Whole Genome Sequencing Technologies (Next generation sequencing Pyrosequencing & Reverse termination sequencing)	4	
Genome Annotation i.e. Mining Genomic Sequence Data, gene prediction methods, Comparative genomics or metagenomics	4	
Module-III: Gene Function & genomic Technologies		CO III
Global Gene Cloning & Expression Platforms & Technologies (Differential Display, SAGE, Microarrays, cDNA-AFLP, etc.)	5	
Proteomics: Protein Structure and functions prédiction (and Analysis)	4	
Proteomics: Protein-Protein Interactions; Protein Arrays, global analysis of protein modifications	5	
Gene Function Technologies (Gene Targeting, Gene Silencing (RNAi))	4	
Module-IV: Application domains of genome technologies		CO IV
SNP Technologies: Platforms & Analysis Haplotyping: Concepts and Applications	4	
Pharmacogenomics: Concepts and Applications in Healthcare	5	
Biomarkers : Identification & Utilization	2	
Total Lectures	42	

Assignments: 1

Marks: 05

Describe gene expression study (pick one) using Microarray from Gene Expression Omnibus (GEO) database

B. Assignment: Each Student will take a research paper and prepare a report based on following point:

a. What is the objective of the their work or question the are addressing

b. what approach or methodologies they have considered and why, to address the questions

c. what is the results

d. Did the authors addressed the question with the result they obtained

e. what is your technical and scienticfic input in their paper if you are critically analyzing the paper?

Examinations	Marks (%)	Duration (hrs)
First Term (T-I)	15	1:00
Mid Term Test (T-II)	25	1:30
End Term Test (T-III)	35	2:00
Teacher Assessment (Based on assignments, quizzes, research paper reading and group discussion, case studies, etc.) Attendance: 5 Participation in group discussions in lectures/tutorials: 10 Assignment/ Case Studies: 10	25	Entire Semester
Total	100	

Reference;

1. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins
2. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
3. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette
4. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz

Comparative & Functional Genomics

Course code 10B17BT671 Credits L0 T0 P1

Objective :

The course is intended to provide thorough understanding of the genomics i.e. modern technologies in whole genome sequencing, genome mining, comparative genomics, global gene function technologies, protein structure & function technologies at the genome level, etc

Course Assessment:

Mid Term P1	20
Teacher Assessment (Based on performance in expts, lab notebook etc.) P 3	60
End Term Exam (P 2)	20
Total	100

Course Outcomes

Students will learn about gDNA, RNA isolation , cDNA synthesis, cDNA library preparation PAGE ,PCR , Real-Time PCR etc.

Suggested text book:

1. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins
2. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
3. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette
4. Molecular Cloning: A Laboratory Manual, Volume 1, 2, 3 J. Sambrook, D. W. Russel Publishing: Cold Spring Harbour Laboratory Press, Cold Spring Harbour, New York
5. Current Protocols in Molecular Biology Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith,Kevin Struhl (eds.)

10B17BT675 (***Core Course***)

DIAGNOSTICS & VACCINE MANUFACTURING TECHNOLOGIES LAB

Credits 1

Lectures 0 Tutorials 0 Practical 1

Pre-requisites: Immunology

Course Objectives:

1. To study various approaches used in protein based diagnostics.
2. To study various approaches used in DNA based diagnostics.
3. To gain expertise and hands-on experience of techniques and instruments used for protein based diagnostics.
4. To gain expertise and hands-on experience of techniques and instruments used for DNA based diagnostics.

Course Assessment:

Mid Semester Evaluation Test	20
End Term Test	20
Teacher Assessment (Based on day-to-day work, practical file, etc)	60
Total	100

Course Outcomes:

CO 1 The students will be able to perform DNA based diagnostics experiment and analysis of data & results obtained independently.
CO 2 Able to design and formulate PCR based protocols for diagnostics and other applications.
CO 3 The students will be able to perform antigen-antibody based diagnostics experiment and analysis of data & results obtained independently.
CO 4 The students will attain knowledge, gain expertise and hands-on experience of instruments used for DNA and protein based diagnostics.
CO5 Able to make proper documentation of lab experiments carried out.

DIAGNOSTICS & VACCINE MANUFACTURING TECHNOLOGIES

(*Elective Course*)
Credits 3

Lectures 3 Tutorials 0 Practical 0

Objective:

1. To familiarize the students with the principles & applications of the latest state-of-the-art bio-molecular diagnostic techniques/technology used in laboratories the world over.
2. The safety aspects, quality control, quality assurance and validation of PCR based diagnostics and laboratory safety.
3. Knowledge of various technologies employed in vaccine production and examine their use in developing vaccines against human and animal pathogens. The safety aspects, quality control, quality assurance and validation of vaccine production and will also be covered.

Course Assessment:

Test - 1	15
Test - 2	25
Test - 3	35
Teacher Assessment (Based on Assignments, Quizzes etc.)	25
Total	100

Course Outcomes:

Lecture Plan:

Topics Covered	No. of Lectures

1. General Introduction – Biotechnology in the diagnosis of infectious diseases and vaccine development, Biotechnology in Vaccine production, Recent developments in vaccine technology.	2
2. Immunodiagnostics –Antigen – Antibody Interaction, Lattice Theory, Precipitin Curve, Simple Immunodiffusion (Radial Immunodiffusion – Qualitative, Quantitative); Double Diffusion (Mechanism of Reaction of Identity, Partial – Identity, and Non-Identity); Immunoelectrophoresis; Rocket Electrophoresis, Western Blot, Immunofluorescence, Agglutination – Antibody titer, Prozone Phenomenon, Direct and Indirect Agglutination, Hemagglutination, ABO Blood typing, Agglutination Inhibition; Immunofluorescence, Radioimmunossay (including advantages and disadvantages).	10
3. ELISA – Theory, Designing an ELISA method, Types – Direct, Indirect, Sandwich, Competitive, Dot ELISA.	2
4. PCR- concept, protocol, strategy. Types of PCR – Strategy and Applications - Nested, Semi-nested, Real time, RT-PCR, Asymmetric PCR, Inverse PCR, Multiplex PCR.	3
5. QC & QA of PCR and Real Time based diagnostics – Theory, Application, and Trouble shooting. Importance of controls. Best Fit Assay, Optimization and Standardization of PCR based diagnostics.	3
6. AST – Concept, KB Method. Laboratory methodologies for bacterial antimicrobial susceptibility testing – concepts, antibiotics –, resistance, mechanism. Disk diffusion, tube dilution, microbroth dilution methods.	4
7. Biosafety and biosecurity in the medical microbiology laboratory and animal facilities.	2
8. Different types of vaccines, i.e., sub-unit vaccines, recombinant vaccines, synthetic vaccines, idiotypic based - vaccines, DNA vaccines, glycoconjugate vaccines, deletion vaccines.	3
9. Examples of different vaccines - Rabies vaccines, PPRV vaccines, Chimeric vaccines – JEV/DENV/Westnile, Meningococcal conjugate & protein based vaccines, Oral B subunit + whole cell cholera vaccine, Multicellular Parasite vaccines, Novel Vaccines against *Mycobacterium tuberculosis,* Mycoplasma vaccines, Protozoal & rickettsial vaccines.	8
10. Genetic basis of attenuation, vaccine vectors, large-scale production of vaccines and automation. . Vaccine delivery system and approaches to enhance immunogenicity - immunomodulators and, immunomodulation	5

adjuvant. Delivery of particulate antigens through liposomes, microspheres etc.	
Total	42

Reference books

1. Burtis, C. A., Ashwood, E. R., Bruns, D. E. :Tietz textbook of Clinical Chemistry & Molecular Diagnostics, Saunders, 2006
2. World Organization for Animal Health : Manual of Diagnostic Tests and Vaccines for Terrestrial Animals, Volumes I & II, 6th Edition, 2010.
3. Rao, J. R. : Molecular Diagnostics: current technology and Applications, Horizon Bioscience, U. K., 2006.
4. Review and Research Publications available on-line
5. Immunology : Kuby

Course Title	Downstream Processing	(Core Course)
Course Code		
Course Credit	4	

L	T	P
3	1	0

Course Coordinator Dr. Saurabh Bansal

Pre-requisite Biochemistry, Bioprocess Engineering

Course Objectives

The objective of the course is to develop an understanding about the importance and functioning of unit operations involved in the downstream processing of the products of a bioprocess.

Course Assessment

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-2
T2 Test	25	1.5 hrs.	Unit 1-5
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Whole Sem	Inform class time to time
Total	100		

Course Outcomes

CO I	Able to understand the importance and financial considerations of downstream processing in compare to upstream processing
CO II	Conceptually sound in understanding about the difference between the downstream processing of intracellular and extracellular products
CO III	Able to understand various separation techniques used in downstream processes
CO IV	Able to design and optimize downstream processes
CO V	Able to understand the requirements for successful operation of downstream processes

CO VI	Able to apply the principles of major unit operations used in downstream processing for the purification and formulation of final products obtained from Fermentation Technology.

Topic Covered

S. No.	Unit	Topics Covered	Contact Hrs.
1	Scope of Downstream processing	Importance of DSP in biotechnology, characteristics of bioproducts, Criteria for selection of bio-separation techniques, Role of DSP methods in bioprocess economics	4
2	Cell Disruption	Various cell disruption methods: Mechanical viz; sonicators, dyno mill, homogenizer, chemical and biological methods.	4
3	Solid-Liquid Separation	Centrifugation: Principles, Centrifuges viz; basket centrifuge, tubular centrifuge, disc-bowl centrifuge. Filtration: Principles, Filter units viz; filter press, Applications.	6
4	Membrane Technology	Merits and Demerits, Reverse osmosis, Ultrafiltration, Microfiltration, Dialysis, Electrodialysis	3
5	Separation of soluble products	Liquid-liquid extraction, Aqueous two-phase extraction, Adsorption, Precipitation	6
6	Chromatographic Techniques	Gel filtration, Ion-exchange, Hydrophobic Interaction and Affinity Chromatography, HPLC, FPLC, Applications.	5
7	Finishing steps for purification	Crystallization, Drying, Lyophilization	4
8	Stabilization of bioproducts	Formulation. Integration of reaction and separation.	2
9	Case-Studies: Process design of Industrial Bio-products	Anaerobic bioprocesses: Ethanol, Lactic acid production	4
10		Aerobic bioprocesses: Citric acid, Gluconic acid, Penicillin production.	4

	Total Number of Lectures	42

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, seminars, assignments and numerical problems will also be given.

TEXT BOOKS

1	Raja Ghosh, “Principles of Bioseparation Engineering”, World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.
2	Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
3	Peter F. Stanbury, Stephen J. Hall and A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd., 2007.
4	M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd, 2008.

REFERENCE BOOKS

1	P.A. Belter, E. L. Cussler, and W.S. Hu, “Bioseparations: Downstream Processing in Biotechnology”, John Wiley and Sons, New York, 1998.
2	B. Sivasankar, “Bioseparations : Principles and Techniques”, PHI Learning Private Limited, New Delhi, 2009.
3	Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri Petrides, “Bioseparations Science and Engineering”, 1st Edn. Oxford University Press, 2002

Course Title	Downstream Processing Lab	(Core Course)
Course Code		
Course Credit	01	

L	T	P
0	0	2

Course Coordinator Dr. Saurabh Bansal

Pre-requisite Biochemistry Lab, Bioprocess Engineering Lab

Course Objectives

The objective of the course is to

- Familiarize the students with laboratory techniques involved in fermentation technology and in the downstream processing of bioproducts.

Course Assessment

Assessment	Max. marks
Mid Term Viva	20
Teacher Assessment (Based on day to day work, performance in experiments, lab notebook etc.)	60
End Term Viva	20
Total	100

Course Outcomes

CO I	Able to set up of different kind of fermentation processes for biomass and product production
CO II	Able to describe and to apply the principles of various unit operations such as sonication, centrifugation, filtration, precipitation etc. used in DSP
CO III	Able to strategize the downstream processes for the purification of various bioproducts such as enzymes, wine etc.
CO IV	Able to design experiments and analyze various data related to various practices in DSP
CO V	Able to analyze and characterize the synthesized bioproducts for further applications

CO VI	Able to work in a team to accomplish the experiments and to make proper documentation of lab experiments carried out in the lab

List of Experiments

S. No.	Unit	Title of Experiments
1	Introduction	Introduction to DSP Lab and related lab safety
2	Fermentation Set up	Setting up of yeast fermentation processes using fruit juice
3	DSP Processes and Principles	Downstream processing of the yeast fermented product (Sedimentation, Filtration, Bottling, Pasteurization)
4	Characterization of products	Quality analysis of the yeast fermented product i) pH, TSS content ii) Sugar content using DNS method iii) Anti-oxidant content iv) Phenolic content v) Alcohol content using alcoholometer
5	Principle of Centrifugation	To determine the effect of speed and time of exposure over the settling of the cells during centrifugation
6	Cell Disruption (Sonication)	Disruption of yeast cells using sonication to recover intracellular Invertase enzyme
7	Enzyme Characterization	Determination of protein and enzyme content in the cell lysate after the cell disruption
8	Fermentation Set up	Setting up of a fermentation process for production of extracellular industrial enzyme (Amylase) from *Bacillus licheniformis*
9	Centrifugation and Characterization	Clarification of the fermentation broth & Estimation of the yield of the industrial enzyme produced by the fermentation process.
10	Precipitation	Concentration of invertase/amylase using salt-induced precipitation
11		Organic Solvent Precipitation
12	Salt removal (Dialysis)	Set up of dialysis to remove the additional salt from the enzyme solution

13	Molecular Wt. Determination	Characterization of enzyme/protein using SDS-PAGE

Methodology

The course will be covered through lectures, demonstration and hands on experiments.

TEXT BOOKS

1	Lab Manual
2	Keith Wilson, John Walker, “Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, Singapore, 2010.
3	Raja Ghosh, “Principles of Bioseparation Engineering”, World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.

REFERENCE BOOKS

1	Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
2	Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd., 2007.

Food and Agricultural Biotechnology

Course Title (Core Course)

Course Code

L	T	P
		0

Course Credit 4

Course Coordinator Dr. Hemant Sood

Pre-requisite Molecular Biology, Biochemistry

Course Objectives

This course is designed to make the students familiar with the processes employed in the manufacture of food products and different techniques used for the production and improvement of agricultural crops along with products through biotechnological interventions.

Course Assessment

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-2
T2 Test	25	1.5 hrs.	Unit 1-5
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Whole Sem	Inform class time to time
Total	100		

Course Outcomes

CO I	Able to learn the mechanisms of preservation methods applied to different food products.
CO II	To understand different bioprocesses involved in food production.
CO III	To provide knowledge of different streams of agriculture having biotechnological interventions.

CO IV	Able to apply knowledge and analyze the problems associated with food and agricultural biotechnology
CO V	Able to apply these methodologies and techniques for developing modified crops and agricultural products
CO VI	To provide insight about ethical ,legal and public aspects associated with food and agricultural biotechnology.

Topic Covered

S. No.	Unit	Topics Covered	Contact Hrs.
1	Basics of food components	Macronutrients and micronutrients, Composition and metabolism of Carbohydrates, proteins and fats. Phytochemicals in foods: Occurrence and characteristics of dietary fibres, polyphenols in foods	5
2	Food Preservation Technology	Role and significance of microorganisms in foods: Intrinsic and Extrinsic Parameters of Foods that affect microbial growth Hurdle Technology: Principles and applications Physical methods of sterilization: Heat treatments (Pasteurization, blanching, canning), Low temperature, dehydration, ultrafiltration, sterilization, irradiation Chemical methods of sterilization: Salting, Smoking, Curing, preservatives Biological methods of sterilization: Biopreservation, Fermentation.	8
3	Food Production technology	Concept of Starter cultures, Microorganisms as foods: Single cell protein, baker's yeast, mushroom, Production of Fermented Foods: Indigenous fermented foods, Lactic acid fermented foods, Production of food additives: Organic acids, Vitamins, Pigments, Flavors	8
4	Recent advances in Food Biotechnology	Nutraceuticals and Probiotics: concepts and application in foods, Food packaging systems	4
5	Quality assurance in Food Industries	Food Standards and Specifications, GMP, HACCP, Quality systems.	3
6	Introduction Agricultural	Agricultural Biotechnology, Conventional method	4

	Biotechnology	of crop improvements vs. Biotechnological interventions, Prospects of Agricultural biotechnologies	
7	Techniques of crop improvement	Different Crop improvement by genetic manipulation taking case studies for herbicide tolerance ,pest resistance etc. Production of phytochemicals and foreign compounds Plant disease resistance ,natural Disease resistance pathways, Biotechnological approaches to disease resistance Case studies	6
8	Agro industrial resources	Transgenic livestocks Transgenic fish technology and products from Macro –Micro algae in agro industry Important crops with their pattern of harvesting and Organic farming	6
9	Microbial Agro-Biotechnology	Bio fertilization and Bioremediation of pesticides and agricultural chemicals	2
10	Ethical Legal and public aspects	Cartagena protocol ,CBD and Plant Varieties and Farmer's Right Act 2001 Prospects and limitations of Agricultural Biotechnology	3
	Total Number of Lectures		42

Methodology

The course will be covered through lectures and presentations. Apart from discussions on topics covered in lectures, assignments and presentations will be taken from students in groups .

TEXT BOOKS

1	Plant Biotechnology- Adrian Slater, Nigel W. Scott and Mark R. Fowler (Text Book)
2	Biotechnology- Expanding Horizons by B.D. Singh

3	Introduction to Plant Biotechnology by H S Chawla

REFERENCE BOOKS

1	Agricultural Biotechnology by Arie Altman
2	Modern Food Micro-Biology - James M. Jay
3	Food Microbiology: Fundamentals and frontiers - M.P. Doyle
4	Agricultural Biotechnology by Arie Altman

Food and Agricultural Biotechnology Lab

Course Title (Core Course)

Course Code

L	T	P

Course Credit 1

Course Coordinator Dr. Hemant Sood

Pre-requisite Microbiology, Agriculture Science

Course Objectives

1. To gain experience in manufacturing and preservation techniques used in food manufacturing units
2. To familiarize the students with basics of biotechnological interventions in food and agricultural sector linked with experimental analysis

Course Assessment

Assessment	Max. marks
Mid Term evaluation	20
Teacher Assessment (Based on performance in experts, day to day performance, attendance, lab notebook etc.)	60
End Term evaluation	20
Total	100

Course Outcomes

CO I	To enable students for apply basic knowledge of techniques used for food and agricultural biotechnology
CO II	Apply practical knowledge to understand the various important parameters involved in food production and preservation
CO III	Able to conceptualize experimental setups related to various practices in food and agriculture
CO IV	To enable students for exploring their avenues for entrepreneurship and social welfare

CO V	Able to use different techniques for the development of different food and agricultural products
CO VI	Able to apply biotechnological techniques for the development of improved products

Topic Covered

S.NO.	TITLE
	Basic guidelines for safety measures to avoid hazard in laboratory.
1.	To determine the quality of a milk sample by methylene blue reduction test (MBRT)
2.	To estimate total phenolic content by a modified Folin-Ciocalteu assay
3.	Preparation of Mozzarella cheese using direct acidification method
4.	To estimate antioxidant activity in foods by DPPH and ABTS assay
5.	To estimate the reducing sugars in the given food samples.
6.	Effect of physical parameters on food spoiling microorganisms
7.	Maintenance, Propagation and determination of activity of dairy starters
8.	Preparation of Yoghurt using defined strain starters
9.	To study different concentrations of kanamycin/ hygromycin sensitivity test on selected plant leaf discs

10.	To perform method of *Agrobacterium tumefaceins* transformation by using toacco leaf disc or seed imbibitions technique, along with molecular analysis of putative transformed plants by GUS assays
11.	Demonstration of suspension cell cultures for metabolites production and HPLC Quantification
12.	Artificial seed production through somatic embryos of medicinal plants, cryopreservation and regeneration into plants

Methodology

The course will be covered through practical experimentation. All students have to performed individual or in groups as per the requirement of the experiment.

Text books
Lab manual

Plant Biotechnology- Adrian Slater, Nigel W. Scott and Mark R. Fowler (Text Book)

Biotechnology- Expanding Horizons by B.D. Singh

Introduction to Plant Biotechnology by H S Chawla

Agricultural Biotechnology by Arie Altman ,Israel

Modern Food Micro-Biology - James M. Jay, (2000), An Aspen Publication, Maryland, USA.

Food Microbiology: Fundamentals and frontiers - M.P. Doyle, L.R. Beuchat and Thomas J. Montville, (2001), ASM press, USA